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TECHNICAL EDUCATION—WHAT IT SHOULD BE.

By Louis Duncan. With Editorial Commentary.

IN this article I will attempt to do two things: first, to state briefly the condition of technical education in the important commercial countries; and, second, to give my notion of the position of technical education in the United States with its difficulties, its mistakes, and its possibilities.

In the industrial battle being fought between nations, the most important weapon is an intelligent man technically educated. This has been acknowledged in Germany for twenty years; in the United States for fifteen years, and it is now being acknowledged in England.

I think that this is true. Any nation that can put on the market a product cheaper than any other nation will sooner or later have the monopoly of the sale of that product. In national politics, tariffs and subsidies may, for a time, give a temporary advantage to one nation or the other, but in the long run it is a question of cheap production. The cost of production depends on two things—the availability of raw material and the brains of the people who develop that material into finished products.

Technical education has taken individual shapes in Germany, America, and England. In Germany it combines with the painstaking acquirement of knowledge, typical of German education, an idea of research; in America it is the old-fashioned general collegiate education modified by paying special attention to technical subjects, with a veneering of manual training; in England to-day it is chaotic, but with a tendency to keep technical education on a trade basis.

As far as facilities go, Germany depends upon State aid, which has been liberally supplied; America, to a large extent upon personal contributions; while England is in the unfortunate position of having little State aid and no large benefactions.

The aim of technical education is to apply scientific discoveries to practical work. When any new discovery is made in science, there are two attitudes to be considered: the first is, how can I develop this discovery; the second is, how can I apply it. Germany, without neglecting the second attitude, has added to its technical instruction the first attitude—that is, the Germans combine research with application. In America, it is only lately that technical education has concerned itself with research work.

Any one who has been through a technical course and afterwards done practical engineering work, will acknowledge this fact: that when a new problem comes up, it is attacked not on the basis of the elaborate detailed instruction which he has received, but from the point of view of a few general principles that should have been instilled into him; and when such a problem presents itself to him, he feels sorry that the details had not been omitted, and the general principles emphasized.

In most of the technical courses given in the average college to-day, mathematics is taught up to and through differential equations, and yet it is so taught that not one in a thousand ever applies differential equations and calculus to practical problems, but works them out with the multiplication table and a slide rule. In mechanics, for instance, instead of being given the fundamental equations and being taught to apply these equations to simple cases, we are given the special solutions of intricate problems, the text books preferring the most elegant solutions, and not laying stress on the direct application of the fundamental equations, irrespective of whether it is difficult or long or ungraceful. And I wish to lay special emphasis upon what I have said about mathematics. As it is given to-day in America, outside of the possible value of the mental training, it has little utility in the life work of an engineer. For example, the value of a graceful solution of the problem of the fall of a pendulum, given to a nineteen-year-old youngster, is problematic. He would enjoy a Sherlock Holmes' story more and it would do him more good. We should do this with our mathematics in technical courses: either drop the calculus and differential equations entirely, or so teach them that the student can apply them in his future engineering work.

The fault of our technical education in America is that it is too

technical and that there is too much instruction. It seems to be the idea that the longer contact the student has with his lecturers or with his text books the more information he will obtain. It does not seem to be considered that information, as such, is not of great importance. It can be obtained easily and cheaply when occasion arises; and the end and aim of a technical education should be not to obtain information, but to apply it. We should not attempt to make mental storehouses of men, but mental factories.

Another thing is this: that to a large extent, the ability of a man to work out any specific problem depends on his being able to make a mental plot of the problem, and to keep it constantly before him. For instance, a railroad proposition for a city, presented to an engineer, involves an infinity of different considerations—the population of the different districts of the city, the character of the population, the growth, the franchises under which the road is to be built, the political complexion of the city government, the question as to whether the capitalists who are building the road intend to operate it or to sell it—these and a hundred other considerations must form part of the plan adopted. To take all these into account, to keep them constantly before one until the scheme works itself out, requires an imagination that has been developed and not suppressed. A large part of the work is done outside of any office—in street-cars, at dinner—unconsciously to a certain extent.

I wish specially to emphasize this point. The amount of work done at desk or before a drawing-board is a very small proportion of the total work needed for a large engineering proposition. The successful engineers are those who can see the problem as plainly while they are walking on the street as they can see it on a blue-print.

I saw some time ago in one of the daily papers a discussion of the requisities for success in life, and some one, I think it was Mr. Cleveland, summed things up by giving as the three requisites, character, persistence, and intellect. The fact that intellect was placed third on the list surprised many people, but this is true. Suppose a brilliant man does a certain piece of work in a certain time; another man does the same work in twice the time; the first is usually considered as having about twice the intellect of the second, and by the ordinary definition of intellect, which emphasizes the time element, this is true. But any one with average brains can work out any reasonable proposition, provided he works at it long enough, and this ability, of which I have spoken—the ability to keep a proposition constantly in front of one, the quality of imagination—constitutes the difference

between the finally effective man and the so-called brilliant thinker. Brilliancy is merely the time-factor of application. Newton said that his success was not due to the fact that he was smarter than other people, but to the fact that he thought more than other people.

The curriculum of our technical courses has for its object the training of students to obtain engineering results under ideal conditions. Electrical engineering, for example, would have been cursed by Thomson's law for the most economical section of electrical conductors, provided any competent engineer ever used this law, which he does not. Still, this law is an important part of electrical engineering instruction. The fact of the case is this: problems cannot be worked out as engineering abstractions, but must take into account financial conditions, political questions, social questions, and all the complex considerations that make up real life instead of ideal life.

In looking over the list of successful engineers (I am speaking now of electrical engineers, because I know very little of any other branch), we do not find that we can point to any one institution as having produced more successful engineers than any other in such a way as to make the difference marked. In fact, I am afraid that our largest and best equipped institutions do not show as fair a percentage of leading engineers as some of the smaller, poorly equipped colleges. I think this is due to two things; the first is that the larger institutions have presented courses including more instruction than can be given in smaller institutions, and I believe that at least half of this has done harm rather than good. The other cause is obvious, i. e., that in the smaller institutions the students are more directly in contact with the instructors, and that they do not have the facilities for work that the more ambitious colleges have; that is, when an experiment is to be tried, the ingenuity of the student, and not his patience, is exercised.

There is another matter which I wish to emphasize. The fundamental ideas of electrical engineering are given in the first two years of our typical American technical course, and afterwards the applications are given without a continual reference to the fundamental principles. In the applications to practical work, each specific case is taken up as a thing apart; there is very little atmosphere of theory.

But outside of the technical training given in any school, there is this thing on which the monetary value, and the real value, of a graduate depends—he must be loyal to his employer. As one who has worked for other people and who has employed other people, I can state this: the value of a man on whom one can absolutely depend is twice as great as the value of one with the same ability who has not a

feeling of loyalty. This does not necessitate any surrendering of self-respect or of independence. It simply means sympathy with one's work and with one's employer.

In the American technical course, the question of manual training has been given different consideration at different colleges. It was pointed out by Professor Sheldon last year that Cornell gave ten times as many hours to manual training as the Institute of Technology. One wonders whether Cornell graduates lose nine-tenths of this time, or the Technology graduates are handicapped one to ten. Frankly, I do not believe that this is a matter of much importance. Few graduates of the technical colleges are called upon to exercise manual-training arts, and the only value is an educational one; although unquestionably the ability to use a lathe or wield a sledge may assist one in the emergencies that arise in the course of engineering life.

To sum up: Germany is supplying a magnificent basis of engineering research, but is weak in the application of this research. In England there is a tremendous gap between Thomson's theory of electrons and instruction in wood-turning. Here in America, we have crowded into twenty years of commercial development the results of two centuries of the world's research, but we are now nearing the end of the researches which we have appropriated, and we must soon either lay fresh foundations or stop building.

R. DUNCAN'S acquaintance with the field of technical education is intimate. As pupil and later as teacher in both undergraduate and post-graduate schools, and at the same time as an engineer constantly active in creative and constructive work of high importance, he has had unrivalled opportunity to study the relation of the school to the worker, and the influence of educational ideals and systems upon the practical cultivation of the talent they are intended to foster. He has watched the technician in the making, in what is perhaps the most characteristic field of the times—that of electrical engineering in the United States. It seems to us, therefore, that it will be of interest to place in comparison beside his views those of some of the foremost European thinkers on the same subject.

There is no dissension as to the ends sought. As Dr. Duncan epigrammatically puts it, the aim is to make of the students not mental storehouses, but mental factories. Nor is there any uncertainty as to the importance of attaining this end if industrial success—which now-

adays includes all success—is to be secured to the nation. As Sir Norman Lockyer says in the excellent address reviewed in full in our Review pages in this issue, "we are suffering because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are too apt to be careless in securing them." As he puts it elsewhere, confirming strikingly the position constantly urged by us editorially in this Magazine,

> "It is a question of an important change of front. It is a question of finding a new basis of stability for the Empire in face of new conditions. It is, moreover, a struggle in which science and brains take the place of swords and sinews, on which depended the result of those conflicts which, up to the present, have determined the history and fate of nations. The school, the university, the laboratory and the workshop are the battlefields of this new warfare.

Mr. Joseph Chamberlain put the statement quite as unequivocally in a quotation taken from the *Times* some two years ago:

> "I would remind you that all history shows that progress—national progress of every kind—depends upon certain individuals rather than upon the mass. Whether you take religion, or literature, or political government, or art, or commerce, the new ideas, the great steps, have been made by individuals of superior quality and genius who have, as it were, dragged the mass of the nation up one step to a higher level. So it must be in regard to material progress. The position of the nation to-day is due to the efforts of men like Watt and Arkwright, or, in our own time, to the Armstrongs, the Whitworths, the Kelvins, and the Siemenses. These are the men who, by their discoveries, by their remarkable genius, have produced the ideas upon which others have acted and which have permeated the whole mass of the nation and affected the whole of its proceedings. Therefore what we have to do, and this is our special task and object, is to produce more of these great men."

And collateral with this strong assent to the proposition that industrial science is the very groundwork of national prosperity is the strong complaint that methods of teaching are not well adapted to the end for which they are intended. Dr. Duncan's criticism is amplified and urged by Professor Charles Vernon Boys, in an address before the British Association:

> "Beyond having time to acquire a few elementary algebraical rules the boy is never introduced to algebra proper; he has no idea of algebraical reasoning; his trigonometry often does not exist, and the very sound or suggestion of coördinate geometry or of the differential calculus, which might be well within his reach, produces a shiver of dismay. . . . If Euclid must be retained let it be translated into English, the English that any parent would use in explaining the ideas to his son; let it be illustrated by constant reference to real things so as to appeal to the boy who does not revel in the abstract. Let the ideas

and the terms first be presented in the form of experiments and of measurements with instruments; let the schoolmaster dare to throw over the intolerable conservatism which prevents our doing anything ten times as well lest some item should prove to be a trifle worse. . . . Is it any use to repeat the long-standing complaint of the way in which the schoolmaster insists upon overdoing his Latin and Greek under the belief that they are at least essential to intellectual development if, indeed, they do not supply the only stimulus? . . . The time given to classics is exorbitant; more must be reserved for those pursuits which draw out the habit of independent thought, creation, and originality."

"I remember in my early days, in the surroundings of a classical atmosphere, the general feeling of contempt for the manufacturer, the intellectually inferior creature who only made money. . . . I am not sure that some such feeling does not still exist among those whose horizon is limited to the Latin and Greek that they have learned—or should I say limited *by* instead of *to*? This recollection came back to me when not long ago I was visiting one of the best organised and most skilfully conducted works in the country—I mean Willans and Robinson—when I remembered that another great manufactory, conducted on American lines, was near by, and when across the road I saw the walls of one of our most famous English schools. I pictured the old contrast: on the one hand the conviction impressed upon me when a boy that there is something intellectually superior in the struggle with a paragraph of Xenophon or a page of Homer, while manufacture is merely mechanical, sordid and base, with what I believe to be the reality on the other. I wondered in what spirit the erection of these works was viewed at the school and to what extent the high intellectual attainment there so essential and so evident is properly appreciated."

Surely it is an eminently proper demand that the training which is to fit its subjects for the highest service in drawing out the nation's material resources, should itself set the example of drawing out the pupil's mental resources—should provide him with the tools most efficient for the work in which he is to be engaged.

The possible relation between technical training and higher education in Germany may be gathered from the noteworthy address delivered before the Society of German Engineers by Professor Ostwald. Concluding an argument for the closer union between the engineer and the chemist he said:

"There are few among those who understand the true condition of educational matters in Germany who do not deplore the mistaken view which is taken by the universities of the movement toward higher technical education during the past fifty years. How then may this unfortunate division between the two greatest elements in the training of the nation be avoided? It is as impossible to conceive of the entire absorption of the technical school by the university as it is to imagine the reverse. Nothing then remains but for each to work out its own de-

velopment with a view to a future co-operation. Already in recent years we have observed a tendency in this direction in the development of independent scientific investigation in the technical schools, this movement being altogether in harmony with the highest aims of the university, and the import of this tendency cannot be too highly emphasised. There is, however, yet lacking a conscious co-operation in this work between the two elements. It cannot be denied that the development of the technical high schools of Germany along the lines of higher learning is not regarded with favor by the universities; while, on the other hand, the work of the universities in scientific research is too often viewed by the technical schools in the light of unauthorized and reprehensible competition. Is it too much to hope that with a better understanding of the limits of each by the other, such narrow views may disappear? I myself believe that such a result may be attained in this as in the union between two branches of scientific work which were formerly widely separated. At least some slight beginning has already been made in this direction, and the auspicious union in the work of the various laboratories of Germany, of which this gathering in Munich is such a notable example, may ultimately be extended to include in similar manner both university and technical high school and impart to each a twofold energy and a twofold influence."

The growth of technical training in Germany has followed naturally upon the general progress which has been made in the last century in the application of science to industry and to the affairs of daily life. In this respect the present position of scientific education in Germany may well be considered as an effect as well as a cause of national development. This point is well brought out in an address by Herr Gustav Schmoller, recently delivered at Munich upon the relation of technical development to national and personal progress, in which he shows clearly the great extent to which the introduction of scientific methods and appliances has promoted personal comfort and national prosperity. Tracing the growth of Germany from its period of great depression at the time of the Seven Year's War to the middle of the nineteenth century, in comparison with the tremendous progress which has been made since that time, he shows how the work which the older education and the older methods of training could not accomplish has been effected by the engineer, by the scientist, by the machine builder, and by the man of applied technology.

The present period, pre-eminently the period of the entrance of applied science into the affairs of daily life, has given to the people of the nation more and better homes, better food, better health, better returns for labor of all kinds. If methods are to be judged by their results, the technologist may join issue with the schoolman without fear as to the verdict.

THE EDITORS.

THE FIXING OF PIECE-WORK RATES.

By Hugo Diemer.

Much of the discussion of shop systems and works management has started with the assumption that rates were already fixed, and has dealt with details of administration only. As a matter of fact, the determining of correct rates is the fundamental starting point of any system. Mr. Diemer's article is based on concrete experience. Discussion of either details or the general principles involved will be cordially welcomed.—THE EDITORS.

THE best field for the use of what is known as the "straight piece-work" system is in an establishment engaged in a strictly manufacturing business. The term "manufacturing" is here employed to convey the idea of the production of the same identical product in large quantity. A more complete definition would state also that a company engaged in a purely manufacturing business is able to anticipate quite accurately its annual output as regards range of sizes and types and quantities of each to be manufactured. Thus companies producing such articles as bicycles, sewing machines, cameras, or agricultural machines, may be put into the class of purely manufacturing establishments, as in contradistinction to works dependent to a large extent upon the receipt of orders whose range of variety and sizes of product may be such as to change the prospective output completely in the course of a few months. To the latter class would belong most establishments manufacturing steam and gas engines, dynamos and motors, and special machinery in general.

The correct basis for piece-work rates is the least possible time required to do the operations involved and turn out a product that will pass the inspecting department as satisfactory. This time is made up of two parts:—1, that spent in preparatory and supplementary work such as jigging, chucking, taking out, gauging, etc.; 2, that spent in active work while the machine is in operation.

The time that should be spent in active machine work is a matter that can easily be determined. In machine-tool work where one workman operates a single spindle it will be limited only by the highest speed that the tools and machinery will stand. In multiple-spindle work there is no advantage in the cutting operation being done more rapidly than the shortest time that will permit of continuous active work on the part of both operator and machine.

It is evident that in a purely manufacturing establishment the variable factors involved in the handling steps can be determined with a far greater amount of certainty than in jobbing work, since in the former case the operation is being done on the same piece in the same manner day after day. A jobbing shop may with advantage go so far as to prepare a routing tag for every piece and specify the maximum feed and speed attainable in machining, and also the minimum time that it is estimated should be taken in the chucking, handling, etc. But in the jobbing shop the average workman is not expected to accomplish the work in the minimum time thus set, since he does not repeat the work often enough to get into a fast gait. Hence the premium wage system with its fixed day rate is gaining in favor in jobbing shops. In fact, there are instances of the premium system being combined with a bonus of a fixed daily amount for the accomplishment of all tasks undertaken and completed in a specified time. In strictly manufacturing processes, however, the workman need not be the good all-around machinist that is required for jobbing work. In fixing the time it should take a man who is working continuously on the same operation to accomplish his work, it is only fair to expect him to turn out the work far more rapidly than would be expected in a jobbing shop. Being less intelligent as a rule and less ambitious than the all-around machinist of the jobbing shop, the workman in the manufacturing establishment cannot be depended upon to turn out voluntarily enough product to earn a fixed day rate. Nor is he apt to be sufficiently ambitious to respond to any inducement offered by premiums or bonuses. It is absolutely necessary to set the piece rate low enough to insure the workingman's exerting himself in order to earn what he considers his day's compensation. Most modern machine-shop work is so much relieved of heavy labor that lively movement on the part of the worker is no hardship. Where the work is heavy, time allowance will have to be made for pauses and intervals of rest.

The hackneyed injunction about the necessity of rigidly adhering to a piece rate once fixed falls flat when applied to rate fixing intelligently undertaken. Piece rates can be made correct at the outset if the work of rate fixing is correctly undertaken, and based upon scientific research rather than upon the guessing which is often misnamed "judging."

Any successful piece-work system will always provide a guarantee to the workman that he will be insured against loss from causes beyond his control. This is easily accomplished by the transferring

of the worker to a day rate when circumstances warrant it. Such transfer should always be recorded by a transfer ticket, stating the date and time of day the transfer is made, together with the reason for the transfer to day rate. These tickets are collected by the time keepers and turned over by them to the pay-roll department, where they should not only be kept on file, but should be noted and compared by some person of authority, so as to avoid too free an indulgence in the transfer to day rate.

There is a growing sentiment prevailing today among progressive machine shops, in favor of a general careful investigation and revision of piece rates. The tests connected with the widespread exploitation of air-hardening tool steels have in many cases revealed the existence of inaccuracies and discrepancies in existing piece rates, that have led to a serious consideration of the adoption of better methods of fixing piece rates than have been formerly employed. The usual method has been for the foremen to decide what the rates should be. In many cases it is quite customary for a foreman to have his time keeper jot down the numbers of pieces on which work is being done and on which no piece rates have been set. These memoranda are allowed to accumulate until a few hours before it is necessary to advise the pay-roll department of new piece rates, with the result that the work of rate fixing is done very hastily. The foundations on which foremen are generally acustomed to base piece rates are previous prices paid for similar pieces, and what the foreman chooses to call his "judgment." Notes based on actual observations of the work are seldom taken, and very rarely are observations recorded on the distinct elements or steps in operations. The general tendencies and attitudes of one foreman will be very different from those of another. The natural result is that similar work is differently compensated in different departments of a factory where the foremen are wholly responsible for piece-work rates.

I do not believe it at all wise to attempt to take away from foremen certain rights with regard to the establishment of piece rates. On the one hand, the foreman has no right to consider himself the supreme authority in his department. The owners of a business certainly have rights in the important question of wages. On the other hand, the foreman feels that he is responsible for the output of his department, and it is not only fair but absolutely essential that his concurrence be secured at every step taken. The ability to secure such concurrence and the good will of foremen in general, is an indispensable qualification of the man in charge of a rate-fixing bureau.

In taking field notes which are to be a basis for piece rates certain simple tools and instruments are indispensable, namely surface speed indicator, revolution counter, calipers, scales, and, unfortunately the stop watch. Various expedients have been tried and suggested for the concealing of the stop watch, but the writer has yet to learn of any such ruse which will not be discovered and word of it spread all over a shop in a very limited time.

A careful investigation and accurate determination of speeds of all machine tools is a prerequisite to the institution of a rate-fixing bureau. This investigation will consist in recording the speeds of line shafts, countershafts, and all spindles, together with all steps of cone pulleys and all variations in speed to be obtained by change gears or any other devices. A card record should be established, indexed by departments, and cross indexed to show all like tools, the individual cards bearing numbers coincident with the serial permanent inventory number attached to each machine tool. On these cards will be recorded the make, style, and age of the machine, together with the speed data above referred to. The proper pulley or gear combination for various diameters of stock at various cutting speeds can also be tabulated on these record cards. The work of calculation involved in such tabulation is greatly facilitated by the use of Mr. C. G. Barth's circular slide rules especially designed for this purpose.

The preparation of the speed record will take considerable time, probably some months. During this time the workmen will have become accustomed to the unconcealed use of the stop watch by one or more observers. The extreme delicacy with which the stop-watch question is here treated may be surprising to some readers. However, in centers of constant labor agitations, every possible agency that may be the spark to ignite the strike fire is necessarily dealt with cautiously.

After several months use of the stop watch in the collection of data necessary for the speed record, it is not likely that any trouble will be created by the use of the watch in recording the time required in the various handling operations.

The preliminary work in connection with the preparation of the speed and machine record may advantageously be accompanied by an investigation of the merits of various makes of tool steel as adapted to the special work at hand.

After the completion of the preliminary work, the real work of rate fixing may begin by taking observations and establishing rates on all new pieces, with the foremen's co-operation, at the same time

OBSERVATION MEMORANDUM

*Piece No.*_____ *Name*_____ *Material*_____ *Department doing work*_____

*Operation No.*_____ *Workmans' name and number*_____ *Machine used*_____

Name and description of operation _____

Peripheral speed (Feet per minute) _____ *R. p. m.*_____ *Revolutions to feed 1 inch* _____ *Linear feet metal removed*_____

STEP No.	STEPS IN OPERATION	STOP WATCH OBSERVATIONS					SUM.	AVERAGE	MINIMUM
		1	2	3	4	5			

*Tool steel used*_____

Time per day spent in grinding tool _____

Time per day spent in adjusting machine _____

*Number of Tools broken per day*_____

Amount charged workman for tool breakage _____

Justifiable time per day not accounted for _____

*Remarks*_____

No. pieces man should do per day based on above _____

Highest number reported done in a day _____

Day rate paid for this class of labor _____

*Piece rate now paid*_____

Piece rate to be paid _____

Sent to _____ *Dept. No.*_____

FIG. I. OBSERVATION MEMORANDUM.

The sheet is 11 inches wide by 8 inches high, ruled and printed in black on white paper.

beginning observations on some single machine, taking piece by piece and operation by operation. If conditions are such that a change in the rate appears desirable and no such immediate change is advisable, the record is valuable to be made use of at the first opportune moment.

A form used by me for an observation memorandum is shown in Figure 1. In many cases not all of the data called for will be obtainable or necessary. Individual tastes will determine the exact size and shape of such a form. A book has always the disadvantage that the original data sheets cannot be easily classified and filed away, as is the case with a loose-leaf system. Referring to the form, the items calling for time spent in grinding tools, time spent in adjusting machine, and justifiable time per day not accounted for, will constitute difficult observation data. They would best be estimated by a whole day's observation on some typical piece of work which could be used as a basis to cover a group of similar jobs. In an establishment where special tool-grinding departments are maintained, the item covering time spent in grinding tools will, of course, drop out. There are few factories in which it would not be advantageous to maintain tool-grinding and storage departments in various parts of the plant. The claim has been made that each man likes his tool ground in his own way and becomes attached to some particular tool which he might not get back from a general grinding room. These points are offset by the fact that some men are much harder on tools than others, and that a skilled grinder will be able often with a few words to tell them where their trouble lies. One of the best arranged tool-storage and grinding rooms I have seen is separated from the general shop by an open heavy wire-net fence, through which the open metal racks, with numbered spaces containing the tools, are plainly visible. The open-rack method of storing tools saves a great deal of time over any storage method employing drawers or boxes.

In securing the observational data, the personality of the observers is a matter of great importance. A carefully selected man can go into the works and take all the observations necessary and at the same time have the good will and friendship of men and foremen. Another man doing exactly the same routine work might easily and unconsciously to himself be considered offensive by the shop hands. The essential qualifications for such observers are, first, a sound and discriminating judgment based on an inherent sense of justice; second, ability to take and appreciate the value of precise observations, such as is developed in laboratory training; third, an unassumed spirit of democ-

AUTHORIZATION SHEET
NEW OR CHANGED RATES AND OPERATIONS.

ORIGINAL

To Rate Fixing Dept. **From Dept. No._____ Date_____ 190__**

THE FOLLOWING CHANGES ARE RECOMMENDED

PIECE NUMBER	CHANGES IN OPERATIONS: NEW OPERATIONS Enter only New Operations in this column	IN PLACE OF If New Operation replaces Old Operation Enter Name of Old Operation here	OLD OPERATIONS Enter only Old Operations on which rate is to be changed	DISCONTINUED OPERATIONS	PRICE PER 100 PCS. NEW PR.	OLD PR.	DIF.

Remarks:

Foreman

Note: Send original and duplicate to RATE FIXING DEPT.
Duplicate must be receipted and returned.

FIG. 2. SHEET FOR CHANGED RATES AND OPERATIONS.

The sheet is 7¼ inches wide and 11 inches high, white paper. A duplicate, pale buff in color, is attached directly behind the original by a gummed upper edge.

racy and modesty; fourth, ability to stand one's ground without creating antagonism. In short, character and tact will be the chief requisites.

In addition to taking observational data, a rate-fixing department should prepare such statistical data and charts as will be valuable in predetermining and checking piece rates. After taking such "field notes" as may be desirable, the observer goes to the department office and "works up" his notes; i. e., he determines on what he con-

siders a fair piece rate for each operation observed, and investigates also the statistics on file, using the statistical information as secondary and not primary reference. After he has thoroughly worked up the results of his study, the observer visits the foremen of the departments in which he took observations with a view to co-operating with the foremen in filling out an authorization sheet covering new or changed rates. The foreman's interest and co-operation is always essential. Hence the authorization sheet should be signed by the foreman, and its arrival in the office of the rate-fixing department should be evidence that the rates have been sanctioned by both foreman and observer. A form suggested for this authorization sheet is shown in Figure 2.

A card index of all piece rates is kept up in the department office by postings from the observation and authorization sheets. The general form and arrangement of this card index will depend upon the nature of the business and product.

The regular routine of the work of the department would consist of a methodical review of all existing piece rates, accompanied by a continuous system of notices of all new work undertaken. Notices of any new pieces on which work is begun and on which new piece rates are desired, are sent by the time keepers in various departments to the rate-fixing department, and an observer from the rate-fixing department responds at once to this call.

A regular routine system as above laid out will be far preferable to an occasional and more or less disconnected series of observations used merely as a stimulus to greater accuracy on the part of foremen. There is danger of the foremen regarding the work as less authoritative and considering that it is being done in a half-hearted way, unless it has the impetus and swing of a regular routine system.

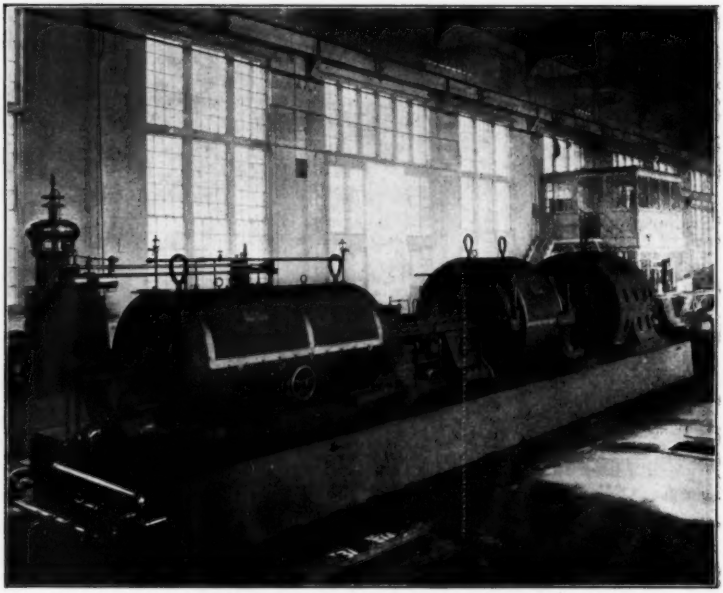
The number of men to be employed in instituting a work of this kind will depend wholly upon the number of pieces to be investigated, and their similarity. The qualifications of the men are such that they are likely to be as high-salaried as the best foremen. While the employment of additional so-called non-productive labor is not in line with any policy of retrenchment, it is evident that present conditions in many large factories are such that the right kind of men working on piece rates could save their salaries many times in a year.

DE BEERS PREMIER MINE, WESSELTON.

THE MECHANICAL EQUIPMENT OF THE KIMBERLEY DIAMOND MINES.

By Chas. V. Allen.

A PRECEDING article sketched briefly the history of diamond mining in Africa, and more particularly the remarkable process of consolidation by which the many petty claims were brought under a single management and an efficient and economical method of mining. The last year has seen many changes in the method of operating the mines, many of these being made necessary by the increased depth to which the mines are now being worked. The introduction of electricity as a motive power is the latest development, this method of driving being installed not only at the mines but throughout the entire kindred holdings of the organization, one of the more important being the large plant for the manufacture of explosives located at False Bay near Cape Town, and known as the De Beers Explosive Works.



ONE OF THE WESTINGHOUSE-PARSONS 1,000-KILOWATT TURBO-GENERATORS.

The De Beers Company have erected a large new power house in Kimberley for supplying electricity to the mines thereabouts, in which they are installing two of the latest type of Westinghouse-Parsons steam turbines. This power house is fitted with eight Babcock & Wilcox water-tube boilers with a heating surface of about 3,500 square feet for each boiler. Additional space for four others has been provided for future extensions. Each of these boilers is fitted with superheater. Mechanical stokers of the chain-feed type are used. All coal is handled by conveyors, and mechanical draught fans are used to create induced draught. Economizers take up the heat of the gases after leaving the boiler furnaces, and surface condensers are used. Circulating and air pumps are also electrically driven by motors. The day-load distributed horse power of the plant is 3,285 and the night-load 2,350 horse power.

In the adoption of the latest development of electrical generating apparatus, the steam-turbine sets, the De Beers Company by introducing this apparatus in this remote country indicate full confidence in this type of apparatus which is now being so generally sought. The particular units which comprise the De Beers installation consist of

steam-driven turbines directly coupled to and mounted on the same base with turbo-generators rated at 1,000 kilowatts capacity, the winding of these generators being three-phase, 5,000 volts. The entire unit makes a speed of 1,500 revolutions, and being four-pole machines they give a frequency of 6,000 alternations. The generators are of the rotary-field type, and when operating at 50 per cent. overload will not exceed 38° C. rise.

The steam turbines have an equivalent overload capacity, so that the actual capacity of the central power house as a whole is 3,000 kilowatts, or about 4,000 horse power. This power house is arranged for the addition of another unit when more power is required.

For exciting the fields of these generators there are installed in this station two motor-generator exciter sets, each consisting of a 50-horse-power 220-volt alternating-current motor mounted on a common base with and direct-connected by means of a flexible coupling to a 37.5 kilowatt 110-volt direct-current generator, the outfit making 720 revolutions. The current supplying these exciter sets comes from a bank of three 400-kilowatt oil-insulated self-cooling Westinghouse transformers, the primary of the same being 5,000 volts, the secondary 220 volts. A suitable switchboard of the latest type of construction provides for the control of these generators, exciter

DRILLING UNDERGROUND WITH COMPRESSED AIR IN THE KIMBERLEY MINES.

sets, transformers, and also the various outgoing 5,000-volt three-phase feeder circuits, as well as the local power-house, auxiliary-motor, and lighting circuits.

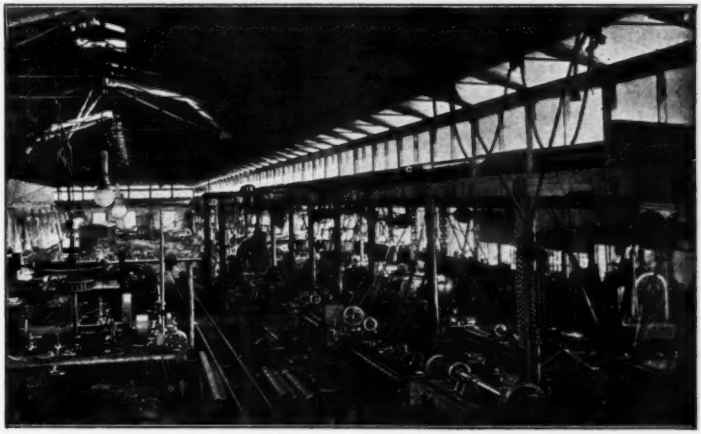
The various motors used in the power station itself, such as those employed for driving the ash and coal conveyors, air pumps, circulating pumps, crane, coal breakers, etc., are operated from 220-volt direct-current and 220-volt three-phase alternating-current sources of power. The alternating motors, which are of Westinghouse make, and of varying capacity, drive Robins coal and ash conveyors, Blake and Knowles pumps, Fraser & Chalmers compressors, etc. The conveying plant is driven by a 10-horse-power alternating-current motor and comprises a 16-inch belt about 175 feet long carrying coal which has previously been passed through two coal crushers driven by a 20-horse-power alternating-current motor. The coal carried by these conveyors is automatically tipped into hoppers above the boilers, this being so done that all the hoppers are kept filled up to a uniform depth.

4,000-TON COAL BUNKER FED BY 24-INCH ROBINS CONVEYOR, WITH TRIPPER. DE BEERS MINE.

In connection with this large mining plant there are fully equipped and very modern machine shops in which small motors have been introduced for driving many of the larger individual tools. In this way a large amount of countershafting and belting has been done away with, resulting already in a great saving in power and in maintenance. As a result of this still further changes in this line are to be made shortly.

For each of the larger tools a separate motor is provided in most

cases. The smaller tools, such as small lathes, shapers, screw machines, etc., are divided into groups of three or four tools and each group is driven by a separate motor. Power is metered out to each shop department, so that it is possible to apportion and determine accurately the power consumed in the various departments of the shop. There will be in all about thirty motors installed, ranging from 2 to 30-horse-power capacity. For these workshops has been provided a synchronous motor of 120-horse-power capacity, three-phase,



DE BEERS MACHINE SHOPS.

220 volts, 600 revolutions, with its exciter, which motor drives a 75-kilowatt, 220-volts direct-current generator, both being coupled together. A suitable switchboard is provided for control of this outfit.

Besides the power operating the constant-speed alternating-current motors and the mining locomotives, there are also in use two small electric hoists requiring motors of about 3 horse power each, and eight larger hoists requiring motors of 75 horse power each. The larger hoists are used intermittently 24 hours per day, the work being continuous for periods of four hours, they being idle only long enough to reverse. The motors operating them are 220-volt induction type. The cages are balanced, the rope being unbalanced; the balance load consists of two cages of about 2,500 pounds each, there being two mine trucks, one in each cage, and the weight of each being about 700 pounds. An unbalanced load of about 1,800 pounds is raised 700 feet through a vertical shaft at the rate of 500 feet per minute after

reaching full speed. A wire rope 2¾ inches in circumference is used, each hoist being provided with a smooth double drum approximately 4 feet in diameter with 24-inch face.

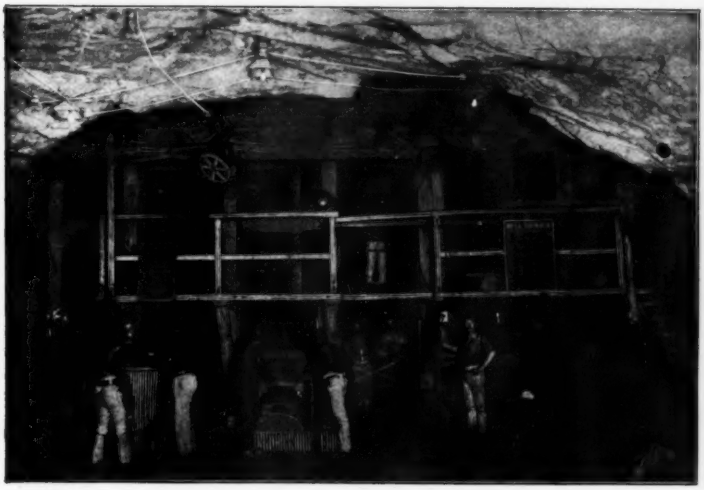
The smaller hoists are operated by the same type of motors hauling an unbalanced load of 600 pounds. The balance load comprises a cage of 800 pounds and a truck of 1,200 pounds, the counterbalance weight being 2,600 pounds. This load is started, raised, and stopped in 20 seconds. The small hoists operate continuously for 12 hours per day. Suitable individual switchboards are provided for the control of all the hoists.

There are now being constructed six Baldwin-Westinghouse mining locomotives, each for hauling loaded trains over a uniform down grade of 0.75 to 1.00 per cent, the load being down-grade. Each of these locomotives is provided with 20-inch wheels, over-all length not including bumpers being 9 feet 6 inches, the wheel base 4 feet. These locomotives operate on a track of 18-inch gauge and the electrical equipment compirses two motors of approximately 10 horse power each, and the usual controllers, automatic car circuit breakers, lightning arresters, diverters, etc. The gauge is 18 inches and the motors have been mounted clear of the wheels. The motor pinion gears in the usual way with an intermediate gear wheel, the journals of the shaft carrying this gear wheel running in boxes working on pedestals over the main journal boxes of the locomotive, and rigidly connected to them. Consequently the locomotive frame, which is supported on springs in the usual manner, is free to rise and fall on the axles without disengaging the gears. The motors themselves are suspended on the shaft of the intermediate gear as though these were the ordinary wheel axles, the usual nose suspension being used.

Each train comprises twenty trucks, each truck when full weighing 3,200 pounds, the empty truck weighing 1,200 pounds. The speed of these locomotives will be about 8 miles per hour on the level track when exerting full-load tractive effort. The rails are 35 and 45 pounds per yard, and the limiting width of these locomotives is 3 feet 6 inches. Each locomotive is capable of exerting a draw-bar pull of 1,100 pounds on the level.

The motors in use in and about the mines are for the larger part wound for 220 volts, 120 volts however being used in places where it is not deemed advisable to adopt the higher voltage.

The power generated at 5,000 volts, three-phase, is carried by means of triple lead and armored covered cables, which have previously been subjected to an insulation test of 10,000 volts between



A SHAFT STATION.

conductors and between each conductor and the lead sheathing, to the various sub-stations, all of which are located below ground in the mines. There are nine of these underground sub-stations, in each of which are installed high-tension and low-tension switchboards. The high-tension switchboards receive the current at 5,000 volts from the transmission cables, pass it through measuring instruments and automatically operated oil switches, through fuse blocks to the primary of transformers. These high-tension boards are each two to three panels in size. The low-tension voltage of these transformers is 240 or 120 volts, as the case may be, this current passing direct to the low-tension boards located in the same sub-station. The following names of the sub-stations, together with the previous description of the mines, will indicate the location as well as the class of work performed by the motors fed by these respective sub-stations.

1—Combined haulage (mining locomotives.)
2—De Beers Mine.
3—Pulsators.
4—Work shops.
5—Kimberley Mine.
6—De Beers No. 4 washing machine.
7—Sanatorium.
8—Bultfontein mines.
9—Premier mines.

Sub-stations 2, 5, 8 and 9 have installed in each of them two low-tension switchboards, one controlling the circuits supplying power and

MECHANICAL HAULAGE, KIMBERLEY MINE.

light on the surface in that vicinity and known as the Surface Distributing Boards, and the other controlling the power and light underground at that place, known as the Underground Distributing Boards. Both the high-tension and the low-tension boards are made up of marble panels supported and fastened together by suitable iron frame work. From the low-tension boards the circuits running to the surface supplying lights and motors are 240 volts, whereas the underground circuits are 120 volts.

In sub-station 8 and 9, in addition to the usual lighting and power circuits on the switchboards, there is installed and controlled on the low-tension board in each station a motor-generator set, consisting of a 50-horse-power alternating-current induction motor, 220 volts, coupled to and mounted on a common base with a 37.5 kilowatt compound-wound direct-current generator, 220-250-volts, this power being used to operate the electric locomotives referred to later.

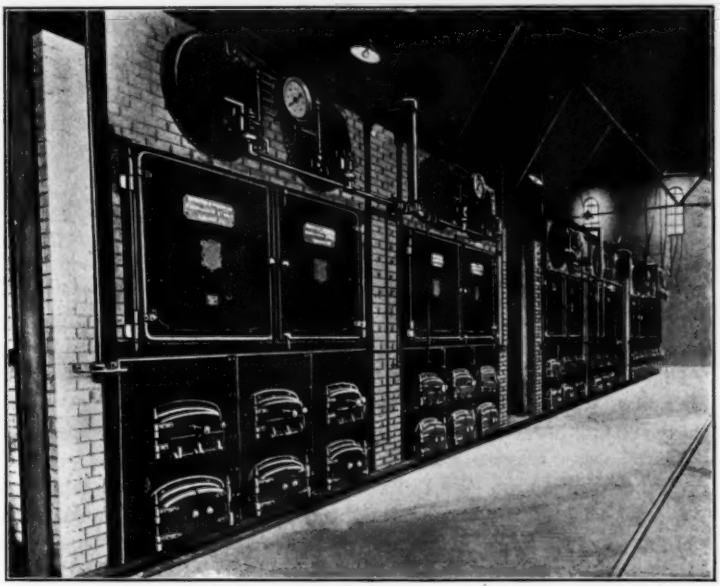
The motors at present installed and receiving their current from these sub-stations are all of the three-phase induction type, 220 volts, 6,000 alternations, and of the following numbers and capacities:

2—1-horse-power	8—10-horse-power
5—3 " "	8—15 " "
10—5 " "	3—30 " "
3—7.5 " "	1—50 " "

These motors are all provided with starting devices located near the motors they operate, an ammeter and fuses also being inserted

in the circuit of each motor to indicate its load. These ammeters, fuses, and starting switches are mounted on little individual motor panels. In addition to the vast number of incandescent lamps fed from these various sub-stations, there is installed in sub-station 1 a motor for driving an arc lighting machine with its exciter.

Polyphase integrating wattmeters are installed on the high-tension switchboards for measuring the power consumed at the respective sub-stations. The lighting and power circuits on the low-tension switchboard have ammeters in them, these circuits also being fused.



SIX BABCOCK & WILCOX BOILERS, 2,531 SQ. FT. HEATING SURFACE EACH, DE BEERS MINE.

The De Beers Consolidated Mines, Ltd., have not, however, confined the introduction of electrical apparatus to electric motors and machines for their mining properties only. Realizing the advantages and saving resulting from the use of modern alternating-current induction motors, they have equipped throughout electrically their various other industrial holdings, such as coal mines, cold-storage houses, and a large new explosive works, each of which is referred to here briefly.

The Indwe Railway Coal & Land Company is in part owned by, and supplies the coal for, the De Beers Consolidated Mines, this company

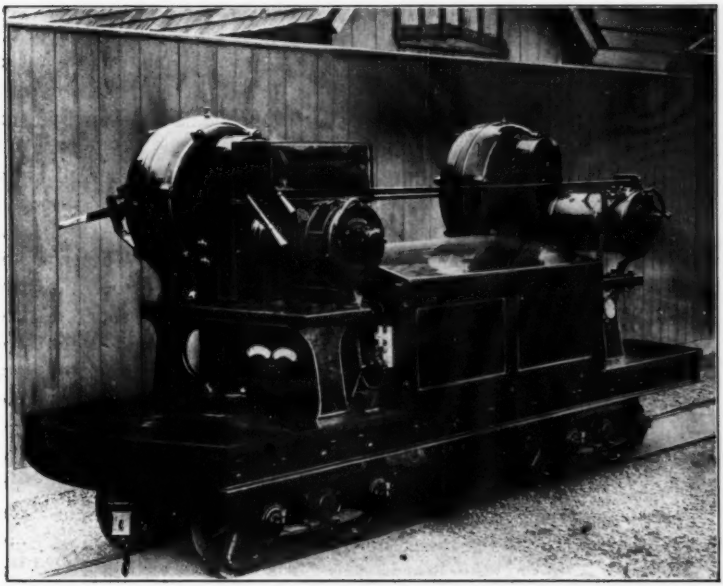
representing an asset of about $417,000. The output of this mine is about 12,000 tons monthly, the De Beers Company taking about 5,500 tons monthly on an average. The De Beers Company also consume about 1,000 tons monthly, taken from the mines of the Stormberg District. Formerly all the coal consumed by the De Beers Company was purchased from England at a very high cost. Recently, however, the Indwe coal has been used and found very satisfactory; its calorific power however is only about 60 per cent. of that of Welsh coal. It is only recently that this mine has been worked extensively. Troubles existing during the recent South African war even necessitated the use of wood, which was obtained from the north, the resultant cost being about twice that of coal.

The lighting and power for this plant is supplied from a power house, in which are installed two 150-kilowatt Westinghouse engine generator sets, the engines being of the compound vertical type working on a steam pressure of 100 pounds and making 250 revolutions, and adapted to work either condensing or non-condensing. The generators are mounted on the extended bed-plates of these engines and provided with outboard bearings. They are compound-wound for 500 to 550 volts direct current, this current being principally for supplying power to the mining locomotives used in and about the mines.

There is also installed in this plant a booster set for increasing the voltage of the feeder circuit running to the Byrne mine. This set consists of a 19.5-horse-power direct-current 500-volt motor direct connected to and mounted on a common base with a 11.25-kilowatt series-wound booster generator of 90 amperes capacity, 125 volts. These machines operate at a speed of 1,175 revolutions. This station is also provided with a switchboard for the control of the generators, four outgoing feeder circuits, and the booster. At the Byrne Mine a receiving switchboard is placed, comprising one receiving panel and a panel for two feeder circuits.

From the 150-kilowatt generator are operated five mining locomotives of the latest and most improved type. The gauge of the track is 2 feet 6 inches and the working load consists of 15 trucks of 1,800 pounds each with their load, the draw-bar pull being 1,200 pounds on the level. These locomotives make 8 miles per hour on level track when developing full-load tractive effort. The weight of rails in these mines is 20 pounds per yard, the average height of tunnel being 6 feet. The length of railroad controlled by this company is approximately 60 miles.

Among the electric locomotives used in the De Beers plants, men-



THE C. W. HUNT ELECTRIC LOCOMOTIVE.

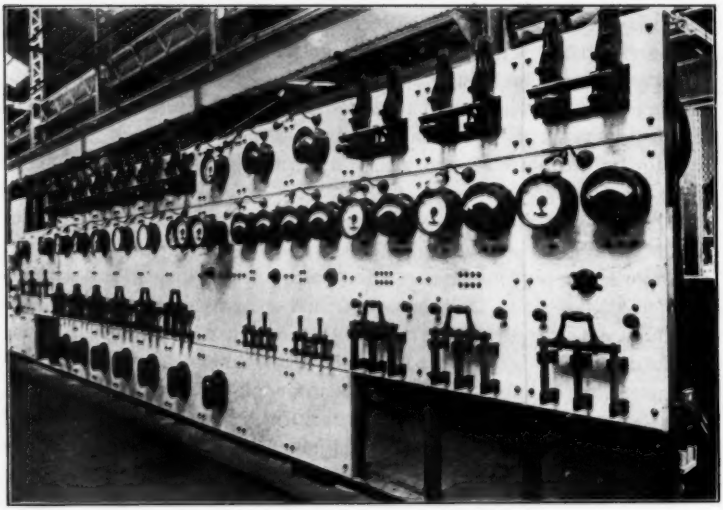
tion may be made of one 5-ton locomotive manufactured by the C. W. Hunt Company, fitted with storage batteries and equipped with two Westinghouse vehicle motors. It is arranged with double truck, the motors and batteries being mounted above the trucks and the axle chain-driven. This locomotive will haul 50 tons on a level. The total voltage on the motors is 100 volts, the battery being divided for charging on a 60-volt circuit.

The De Beers Company also own a large interest in the Imperial Cold-Storage Company, and in 1902 absorbed the Australian Cold-Storage & Supply Company. The taking over of this branch of business by the De Beers Company was quite a departure from its regular business. It proved, however, to be a great help to the English during the war, and has since been a very valuable source of revenue to the Company. Not only this, but the local people have profited by being able to obtain meats and provisions at a much less cost than before its establishment. In this plant there is installed a 75-kilowatt generator supplying current to three 30-horse-power and two 40-horse-power 220-volt 7,200-alternation induction motors, this power being consumed in driving ammonia condensers, etc.

Probably one of the best equipped explosive factories in the world, and certainly the most modern, is the De Beers Explosive Works, which is equipped electrically throughout. In establishing this plant it was the company's intention to sell a great deal of their output to mining interests in Johannesburg and thereabout, and thereby earn a good revenue besides supplying all the needs of their own mines.

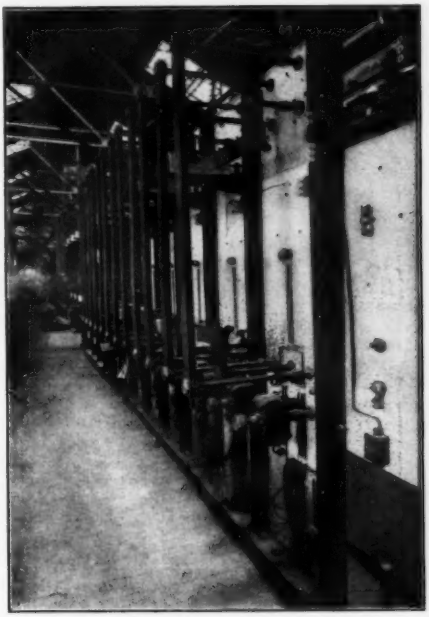
In the electrical generating station of this plant are installed three 300-kilowatt Westinghouse-Parsons steam-turbine generator outfits, made in England. They are supplied by steam at 150-pounds pressure and operate at a speed of 3,000 revolutions. These generators are two-pole, 6,000 alternations, three-phase, 440 volts. Most of the energy of these machines is consumed in motors. These turbo-generators are excited by two sets, one motor-driven and one steam-driven, each being capable of exciting the fields of all three generators.

A ten-panel switchboard is provided for the control of these three generators, the two exciters, and the motor driving the motor-exciter set, also controlling six feeder circuits each on a separate panel. These supply the various motor circuits in and about the explosive works, from which are operated some 100 to 125 constant and variable-speed induction motors. The work which these motors are called upon to perform is of an extremely varied nature and again well indicates the



FRONT OF SWITCHBOARD, DE BEERS EXPLOSIVE WORKS.

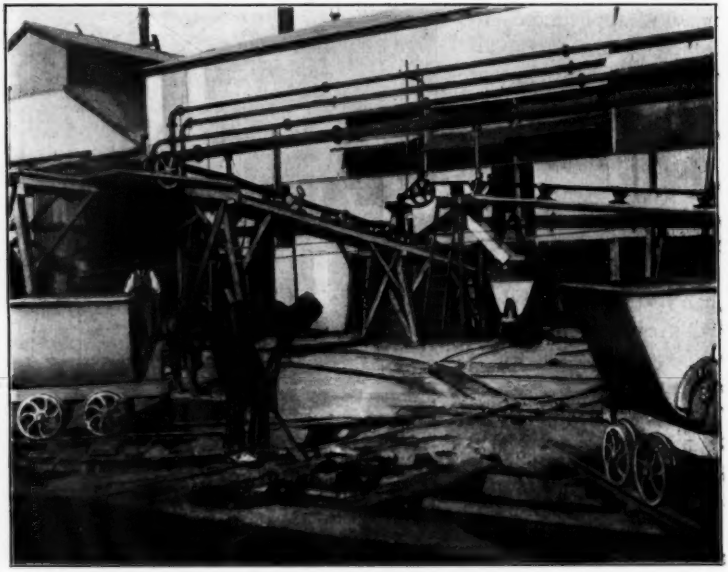
many applications to which the modern alternating-current motor may be applied. The constant-speed motors are provided with oil-immersed auto-starters and gas-proof enclosed fuse blocks. The two-speed and variable-speed motors are provided with oil-immersed controllers and the same type of fuse blocks. These controllers are similar to the drum street-car type in appearance, being provided with starting notches and capable of reversing the motor where occasion requires. The two speeds of the two-speed motors are obtained by changing the combination of motor coils, such as changing from four to eight poles, by a proper combination of fingers and notches on the controller.



SWITCHBOARD, DE BEERS EXPLOSIVE WORKS.

The variable-speed motors in this installation are constructed similarly to the induction motor, except that the rotating or secondary element is provided with a three-ring collector from which leads are run to the oil-immersed controllers connecting with suitable resistances. By this means a varying amount of resistance is inserted in the secondary winding of the motor, resulting in a variation of speeds.

As an example of this last-named motor, there is in service a 10-horse-power motor used to drive a vertical triplex Blake pump, the motor being geared to the pump and mounted on its extended bed plate. As it is necessary to vary the speed of the motor at least 50 per cent, this type of motor meets admirably the condition required and allows water to be supplied to the boiler as needed. In the boiler house are installed both steam and electrically driven pumps, each pump delivering 30,000 pounds of water per hour against a discharge head of 160 pounds per square inch at a piston speed of 100 feet per



ROBINS BELT CONVEYOR HANDLING BLUE GROUND AT THE DE BEERS MINE.

minute. As an example of the work done by motors of the two-speed type, reference might be made to a 60-horse-power motor operating an air compressor, which is capable of delivering 12 pounds, or about 320 cubic feet of free air, per minute against a discharge pressure of 80 pounds per square inch. The speed of compressor when working at rated capacity is 57 revolutions; it is belted from a jack shaft driven by the motor. This compressor has a Corliss inlet valve and a Riedler outlet valve, and is unique in that the Corliss valve is fitted with a triple gear so that only the amount of air which is required is taken into the compressor, and this automatically. Power-driven compressors as a rule either do no work through their unloading devices other than the friction of the machine, or do whole work against the receiver pressure. This brings extreme fluctuations on the motor; this trip gear is so arranged as to do away with these fluctuations. Further, this trip gear, when starting up, allows for the motor starting up with light load on the compressor—that is, if no trip occurs the inlet valve remains open during the whole of the forward and return stroke, so that the air is simply drawn in and blown back again through the same valve and consequently no work done. If the full capacity is required

these valves are tripped and closed exactly at the end of the suction stroke, or at any other point according to the capacity required.

A variable speed motor also runs a Gurden Pump of Fraser & Chalmers make used as a circulating pump to circulate the water through the jackets of the compressor for cooling. This pump is under a suction of 2 feet 9 inches. The advantage of this pump over the ordinary centrifugal pump is that the centrifugal has to run at constant speed and requires a full bore of water to be constantly supplied to it. Further, it will not suck from the lift and must be continuously primed. This Gurden pump takes the water as it is supplied to it with a suction lift, and delivers the water according to the rate required, the speed of the motor, and therefore the speed of the pump, being variable. The capacity of this pump is 160 gallons per minute when running at 100 revolutions, although it can be run at a higher speed if required.

The refrigerating plant in this explosive works makes use of two 75-horse-power motors driving, by belts, ammonia compressors each capable of circulating 25 pounds of ammonia per minute when working against condenser pressure of 200 pounds.

As giving an idea of the varying uses which can be applied to these motors a table of the motors installed in this plant and the work performed by them, together with the horse-power capacity of each, is given on page 162.

For obvious reasons, great care is necessary to prevent arcing or sparking in the explosive works, and this is entirely assured by the use of induction motors with fuses, starting devices, and controllers protected as described. Numerous transformers of the Westinghouse shell-type construction, of varying capacities, are used to reduce the voltage from 420 volts, the main line voltage, to 110 volts, that desired for the lighting service.

The transportation of all the above electrical apparatus from New York by water has been to Cape Town, Port Elizabeth, Durban, and East London. Most of the apparatus for the diamond mines plant was handled at Port Elizabeth, Algoa Bay, and that for the Explosive Works at Cape Town. The transportation by rail to destination has been over single track roads of 3 feet 6 inch gauge.

The devising of methods to overcome the many problems which have arisen and their successful execution is largely due to the present Manager, Mr. G. F. Williams, from whose recent book, "The Diamond Mines of South Africa," much of the above information is taken by courteous permission of the author and the publishers—the Macmillan Company.

LIST OF ELECTRIC MOTORS IN THE DE BEERS EXPLOSIVE WORKS INSTALLATION.

Location.	Drives.	No.	Horse power each.
Nitro-glycerine houses	Shafting	4	7½
Catchment system	Centrifugal pumps	3	3
Mixing houses	Shafting	9	10
Squirting houses	"	9	5
Olin Scott mixers	"	2	10
N. G. cooling system	Centrifugal pumps	2	2
Acid-cooling house	" "	3	2
Nitrating house	3 Centrifugal pumps	1	20
" "	3 Washing	1	10
" "	2 Fans	2	3
Pulping house	2 Beating engines	2	30
" "	2 Centrifugal pumps	2	5
" "	2 Washing centrifugals	1	7½
Cotton-waste dry house	Fan	1	5
Cotton-waste dry house	Picker	1	7½
Wood-pulp dry house	Fan and seive	1	5
Cartridge house	Paper cutter	1	5
Two box houses	Nailing machine	2	5
Nit. soda dry house	Nitro wheel	1	5
" " " "	Fan	1	5
" " " "	Nitre mills	1	20
Machine shop	Shafting	1	5
Carpenter shop	"	1	20
Blacksmith shop	Blower	1	1
Foundry	Shafting	1	10
Boiler shop	"	1	10
Brick factory	"	1	40
Rock crusher	Rock crusher	1	7½
Sul. acid works	Shafting	2	40
Heating systems	Centrifugal pump	3	1
Rain-water service	" "	1	1
" " "	" "	1	2
Refrigeration plant	Am. compressor	Total H. P.	150
" "	Auxiliary ap.	" "	20
Power house	Air compressor	" "	60
" "	Cooling tower	" "	30
" "	Air pump	" "	15
" "	Water circuit pump	" "	50
" "	Boiler feed pump	" "	5
" "	Economizer scrapers	" "	2
" "	Coal crushers	" "	10
" "	Conveyers	" "	10

AN EARLY BRITISH COLLIERY. SKETCH OF THE "HARRINGTON MILL PITT COLLIERY."
Reproduction of frontispiece of old treatise on Coal Mining in Durham and Northumberland, by Mr. J. H. H. Holmes, 1816.

THE COAL-MINING INDUSTRY OF THE UNITED KINGDOM.

By R. A. S. Redmayne.

II. RECENT DEVELOPMENT IN BRITISH COAL-MINING.

In the introduction to Professor Redmayne's first article, which appeared in our issue for October, it was pointed out that Great Britain's early and systematic development of her coal resources, in connection with her enormous industrial and commercial expansion, had given her a long pre-eminence as a fuel producer. Professor Redmayne addressed himself first to the historical review of the era of her undisputed supremacy, and to the early effects of machinery in the vast betterment of the condition of the workers. The paper now presented follows the subject through the later epoch of scientific working and the extending use of power-driven machinery, under the increasingly apparent pressure of competition from the vast coal output of newer countries. This leads naturally to the third and concluding article, to appear next month, which will deal with the economic aspects of the problem and especially the rise and prospects of the American export coal trade.—THE EDITORS.

THE nineteenth century has been well named the "age of coal," and certainly the early part of the century witnessed developments which in magnitude far outweighed any of those of the preceding history of the trade.

With increased and increasing demand came the necessity of opening out lower seams, and deeper shafts meant a heavier capital expenditure in colliery enterprise. It is remarkable how little the outside public realise of the great difficulties that often have to be overcome in sinking—such as passing through water-bearing strata or running sands—or of the enormous cost entailed by some colliery developments.

As early as 1829 Mr. John Buddle, in giving evidence before the

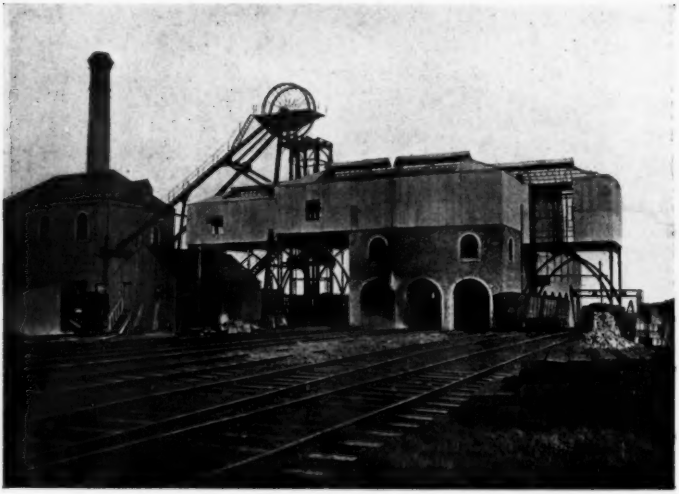


FIG. 2. A MODERN BRITISH COLLIERY. ASHINGTON COLLIERY, NORTHUMBERLAND.

House of Lords, declared that the cost of sinking, even then, was frequently £10,000 to £15,000; and Mr. J. T. Taylor stated before a select committee on rating of mines in 1857 that at Haswell Colliery in the county of Durham, £40,000 was expended in contending with a quicksand, and that the shaft had ultimately to be abandoned. At Murton Colliery, a few miles distant from Haswell, £300,000 was expended in sinking, the quantity of water pumped during the operation of sinking through the overlying magnesian limestone bed amounting to an average of 9,306 gallons per minute from a depth of 540 feet; and the three shafts ultimately reached the Hulton seam, at a depth of 1,488 feet from the surface, in April 1843. Many deep and costly sinkings —several much deeper than in the last instance—have been put down since the Murton Winning, but none, I believe, at a greater expenditure of capital, owing, doubtless, to the greatly improved methods now employed in carrying out such operations through watery strata—notably the Kind-Chaudron system whereby the shaft is *bored* out and the side protected by metal cylinders lowered from the surface; and the Poetsch or Gobert methods whereby the water is frozen in the "running" sand, or other water-bearing stratum, and the shaft sunk through the solid mass. The pits at Whitburn Colliery, near Monkwearmouth, County Durham, were put down through the magnesian limestone by the former method, and part of the New Winning at

Washington Colliery, in the same county, was last year carried out by means of the Poetsch system of freezing the ground.

The question of waste in working coal is one of ever increasing importance. Indeed, the requirements in coal mining may be epitomised as the production of the greatest possible quantity of coal from a given area, in the best possible condition, at the lowest possible cost compatible with safety to life and property. And as bearing upon this, a brief survey of the modes of working coal in Great Britain will not be amiss. The methods are four, of which there are many modifications.

1.—The "bord and pillar," or "stoop and room" method, mostly in vogue in the Great Northern coalfield and in Scotland, consists, briefly, in dividing up the mine into districts or panels (panel work) of pillars, (see Figure 3) the districts being separated by barriers of solid coal: this is called the first working, the pillars and barriers being removed in what is termed the second working.

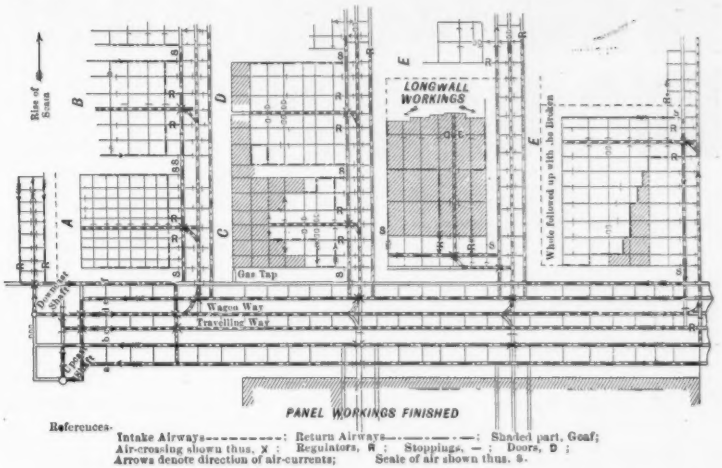


FIG. 3. SKETCH PLAN OF A MINE WORKED ON THE PANEL SYSTEM.

2.—Closely connected with this mode* is that known as the "stall method"—"single or double stall"—chiefly practised in South Wales and particularly so in the anthracite district of the coalfield. In other parts of the field it is being superceded by longwall. The manner of working is to drive roads or stalls, usually about 12 yards wide, into the

* The "stall" and the "square" methods of working may perhaps be regarded as modifications of the bord and pillar system.

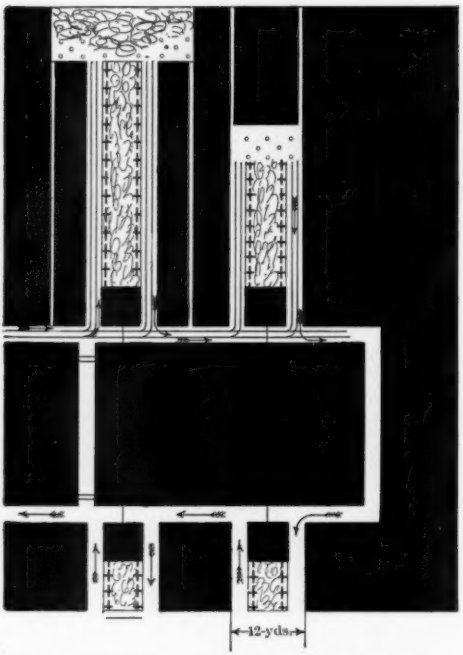


FIG. 4. DOUBLE STALL WORKING. ARROWS DENOTE DIRECTION OF VENTILATING CURRENT.

solid coal (Figure 4), an open road being kept in the case of double stall, along either side of the stall against the solid coal, for passage of men or haulage of coal; the roof in the middle portion is allowed to fall or is stowed with debris, the ribs between the stalls being worked back when each stall has attained its specified distance, which may be anything between 30 and 130 yards.

3.—The system known as "square work," in operation only in South Staffordshire and Warwickshire, is the only satisfactory way, as yet devised, of working the so-called 10-yard seam (the thickest coal seam in the United Kingdom) of those districts, though it cannot be said to fulfill all the requirements of coal mining, seeing that it is the most wasteful of all the systems alluded to; but a very thick seam is not so economically or satisfactorily worked as a moderately thin one, other things being equal. The thick coal of South Staffordshire varies from 8 to 12 yards in thickness, and is divided into a series of layers by thin "partings," the seam being, in reality, an agglomeration of many coal beds which further north exist as separate seams. The horse roads are made in the bottom coal, and the "side of work" driven out in the form of a parallelogram 50 yards or more in "the side," each "parallelogram" being divided from the adjoining one by a rib of coal 7 or 8 yards thick (see Figure 5). The roof coal is then cut down in beds according to the partings in the seam, small pillars being left to support the roof. Though these pillars and the ribs are left as small as

possible, the loss of coal is nevertheless very great, oftentimes as much as 20 per cent.* Eventually each side of work when abandoned is dammed off to exclude the air and prevent the spontaneous combustion of the small coal or slack made by the crushing of the left pillars and ribs. The thick coal is very liable to spontaneous combustion and underground fires are of common occurrence in this field. As the thick coal is known to exist at a very much increased depth east and west of the great boundary downthrow faults, (and, indeed, is already being worked on the eastern side by the Hampstead and Sandwell Park collieries, and is being sunk to on the western side at Baggeridge), the difficulties of working will be aggravated by the great amount of crush due to the depth, and will in the near future tax the ingenuity of the mining engineers to the utmost.

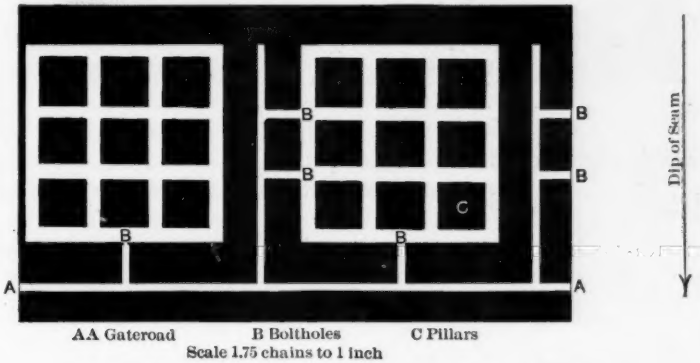


FIG. 5. PLAN OF SOUTH STAFFORDSHIRE SQUARE WORK.

4.—The "longwall" system, (Figure 6) sometimes known as the Shropshire method of working, owing to its having been first carried out in that coalfield, is perhaps the method in most general use, and is especially suited to thin seams, seams having either a fireclay or ironstone roof or floor which is being worked simultaneously with the coal, or seams of coal containing interstratified bands of stone. The coal is removed entirely in one working, the vacancy packed with stone, and the haulage, travelling, and ventilating roads kept open through the waste ("goaf" or "gob"). In some cases, however, it has been

* This refers only to the first working as here described; frequently, however, the ground is gone over again, and the pillars and ribs in a great measure removed. Indeed, the writer has been recently informed by a mining engineer, who has had many years' experience in working the thick coal by "square work," that in some instances he had practically recovered all the coal in a given area.

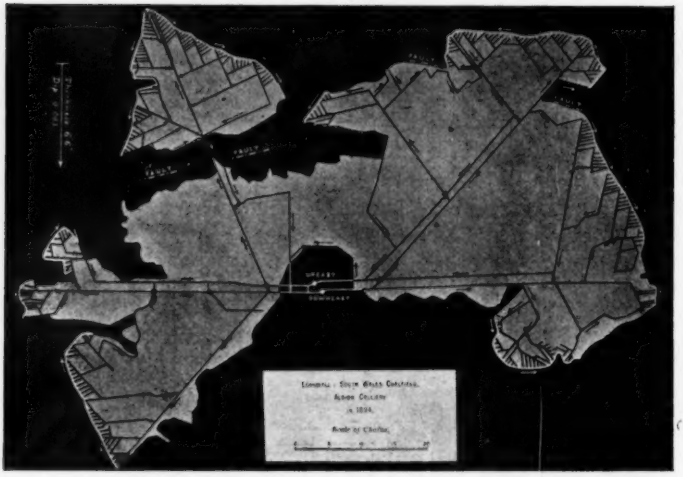


FIG. 6. PLAN OF LONGWALL SYSTEM OF WORKING.

deemed advisable to drive these roads out from the shafts to the boundary and work the longwall back to the shafts, this being known as "retreating" in contradistinction to the "advancing" system of longwall.

The "square" or "wide work" is by far the most wasteful of the methods of working coal, the "bord and pillar" and "stall" methods being very much less so, and although it is usual to allow in calculations 5 per cent. for loss of coal in working by these two last systems, it will be found that it is less than this in actual practice when either of these systems is well carried out. Longwall is the least wasteful system of all. Mr. James Dixon, in his presidential address before the members of the Institute of Mining Engineers last year, went into the subject of loss of coal in working. He compared the actual production with that calculated as being contained in certain areas worked over by bord and pillar and longwall in seams of various thicknesses. In one case three-quarters of the workings were on the bord and pillar system in four seams 3¾ to 7 feet thick, with good and bad roofs. The results were:—

By calculation the area contained 4,910,122 tons.
By output there were recovered 4,895,378 tons,

or a loss of only 0.3 per cent.

In another colliery where the workings of five seams from 2 to 4 feet thick were carried on entirely under the longwall system,

The results by calculation were 2,875,487 tons,
The results by output were 2,910,173 tons,

showing a gain of fully 1 per cent.*

Mr. Dixon arrived at the conclusion that in well managed workings on the bord and pillar system the loss in working is reduced to a very low percentage, whilst in longwall practically the whole of the coal contained in the excavated area is recovered. As the subject of waste of coal, in mining and in consumption, is before the Royal Coal Commission, their conclusions are being awaited with much interest.

Whereas the slack or small coal used to be left underground, and, therefôre, was not included in the earlier computations of the annual output of coal from the United Kingdom, little or none of it is now left, as small coal is in much demand for manufacturing, coking, and other purposes.

FIG 7. MINERS WORKING A LONGWALL FACE IN A THICK SEAM (6 FEET).

Not only may it be said that the latter half of the nineteenth century witnessed considerable improvements as to economy in modes of working and efficiency of underground ventilation, as well as in respect to winding, haulage, pumping and ventilating machinery, and the application of compressed air to mining operations, and in colliery administration generally, but it was also marked by the introduction

* Of course a good deal turns on the manner of calculating the contents of a coal seam over a given area, but given the average thickness of the seam, and the specific gravity of the coal, the calculated results should be very near to actuality.

of means rendering possible very considerable saving in the consumption of fuel, and also in the utilisation of classes of coal hitherto regarded as of small value. Coal which up to this time had been debarred from the markets came to be worked, leading to colliery developments in fields which had been more or less neglected.

The extent and relative positions of the British coalfields are shown on the accompanying map, Figure 7, in large measure a copy of that submitted by Professor Hull to the last Royal Coal Commission and published by them in their report of 1871.

Professor Hull has divided the coalfields as follows, and his arrangement is reproduced here as being the most convenient.

I. ENGLISH COALFIELDS.

Midland Group. 1, North Staffordshire; 2, South Staffordshire; 3, Leicestershire; 4, Warwickshire.

North Midland Group. 1, Yorkshire, Derbyshire, and Nottinghamshire.

Great Northern Group. 1, Durham and Northumberland; 2, Cumberland.

North-Western Group. 1, Lancashire and East Cheshire; 2, Coalbrookdale (or Shropshire); 3, Forest of Wyre.

Western Group. 1, Bristol and Somersetshire; 2, Forest of Dean.

II. WELSH COAL FIELD.

1, South Wales; 2, Denbighshire; 3, Flintshire.

III. SCOTTISH COAL FIELDS.

1, The Clyde Basin; 2, Midlothian; 3, Haddingtonshire; 4, Fifeshire; 5, Ayrshire; 6, Leshmahagow; 7, Canobie.

To which must be added, though they are not of great significance:—

IV. THE IRISH COAL FIELDS.

1, Northern Group.

2, Southern Group.

It is probable that the coalfields of Great Britain are in the majority of cases of the same age geologically, and at one time constituted one continuous coal area, now, through the agency of denudation, forming detached areas; yet as to the nature and quality of the coal considerable diversity exists, and this variation coupled with the abundance of the different qualities has done more than anything else to establish British commercial greatness.

Coal mining until comparatively recent times was carried on chiefly in the Great Northern or Newcastle Field, Staffordshire, and Scotland.

and to some extent in South Wales, where the broken character of the country with outcropping coal seams in the valleys allowed of easy mining; the more general development of this field, however, came later. Gradually the other coalfields began to be developed, so that at the present time, whilst some of the coal-mining districts may be regarded as progressive areas, that is to say, have not yet attained the zenith of their productive development, others are either stationary or retrogressive. Some of these fields, such as the Great Northern field, may show increased annual production, but this is due rather to the augmentation of the output from existing collieries than to any further extension of development.

FIG. 8. "DEPUTY" ENGAGED IN DRAWING TIMBER IN A LIFT.

Those of the proved coalfields chiefly allowing of further colliery expansion are the North Midland and South Wales fields, and part of the Midland field; but even these will, within a comparatively short time, be fully exploited and will have reached the zenith of their development, leaving only the hidden coalfields for the consideration of those desirous of opening out new collieries.

Allusion has been made to the great variety of coal mined in the United Kingdom, and it may be further added that this variation in quality is peculiar also to individual fields. For instance, good coking coal is mined near the banks of the River Tyne, west of Newcastle, yet close to Newcastle itself the celebrated Wallsend household coal

is produced. What is said to be the finest coke in Europe is made from coal worked in the western and south-western portion of the Durham part of the field, yet good gas and first-class house coal are raised from the colleries in the central and eastern districts.

FIG. 9. NEW HARTLEY COLLIERY, NORTHUMBERLAND. A MODERN BRITISH PLANT.

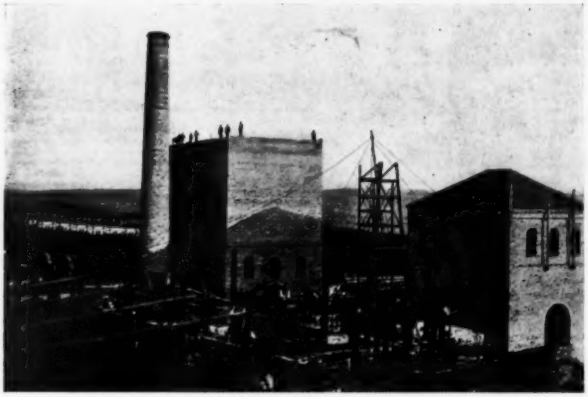


FIG. 10. COLLIERY HEAPSTEAD IN COURSE OF ERECTION.

The chief steam-coal producing districts are South Wales, Northumberland, some of the Scottish fields, and to some extent also Lancashire and North Staffordshire, and Yorkshire; but the Midland fields yield, principally, house, manufacturing, and iron-smelting coals, as well as gas and coking coals.

The quality of British steam coal, especially that derived from the

FIG. II. THE COAL-FIELD AREAS OF GREAT BRITAIN.

central part of Glamorganshire in the South Wales coalfield, is regarded as superior to all other steam coal at present in the markets of the world.

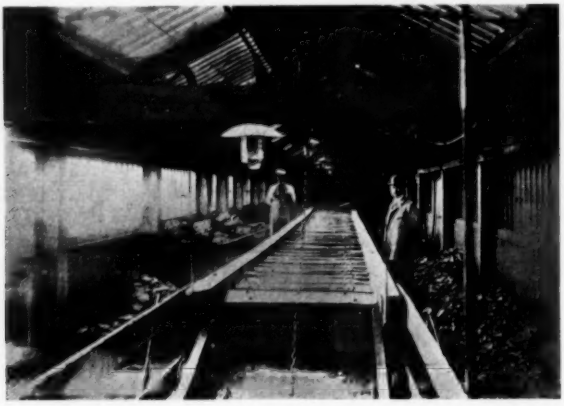
The South Wales coalfield, with the exception of the Clyde basin, is the largest in the United Kingdom, taking into consideration only the exposed portion of the latter field (see map, Figure 7). It is also remarkable for the great variety it presents in the character of its seams. In Monmouthshire these are bituminous, but become less so* towards the south-west, until in Mid-Glamorgan they constitute the smokeless steam coal used in the Royal and other navies. Towards the west (Pembrokeshire) the seams pass into anthracite.

* A coal containing a high percentage of volatile hydrocarbons—that is, a bituminous coal—is sometimes spoken of as a "fat" coal, whilst a coal possessing a low percentage of volatile matter, but a high percentage of fixed carbon, is alluded to as a "dry" or steam coal, thus:—

An anthracite.....	would contain	88 to 92	per cent of coke	and	12-8	volatile matter.
A semi-bituminous or steam coal	"	"	82 to 88	"	"	18-12	"	"
A bituminous coal { Clear burning	"	"	74 to 82	"	"	26-18	"	"
A bituminous coal { Flaming	"	"	68 to 74	"	"	32-26	"	"
A bituminous coal { Fuliginous	"	"	60 to 68	"	"	40-32	"	"
A gas coal.....	"	"	50 to 60	"	"	50-40	"	"

The annual production from the several mining districts in millions of tons towards the close of the last century may be taken as follows:—

Scotland.	Fifeshire	5½	million tons.
	Lothian, Clyde and other coalfields	23¼	million tons.
	Ayrshire	4	million tons.
England.	Great Northern coalfield	45	million tons.
	Cumberland	2	million tons.
	Midland. Yorkshire, Derbyshire, Nottingham, Leicestershire	52	million tons.
	Lancashire	23½	million tons.
	N. & S. Staffordshire, Warwickshire, Shropshire, Worcestershire, Gloucestershire, Forest of Dean, Bristol	19½	million tons.
	Somerset	1	million tons.
	Monmouthshire	9½	million tons.
Wales.	North	29½	million tons.
	South	3	million tons.
Ireland.		1/10	million tons.



TRAVELLING BELT FOR SORTING COAL AT A BRITISH COLLIERY.

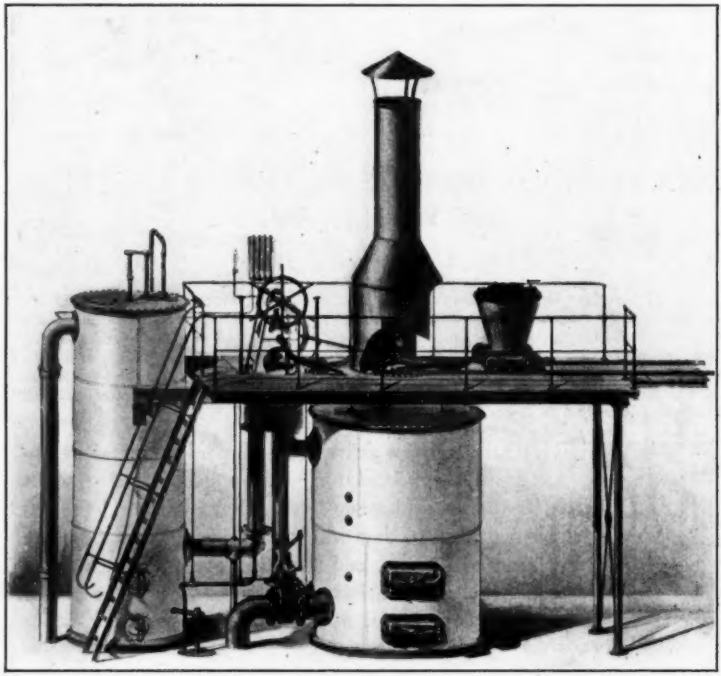
RECENT DEVELOPMENTS IN THE PRODUCTION OF WATER GAS.

By A. Humboldt Sexton.

One of the most important developments in the economy of power production in the near future is that connected with the extension of the use of gaseous fuel. One need only glance at the history of the internal-combustion engine during the past few years to appreciate one phase of this importance. It is this consideration which gives interest to the demonstration of any method of improving the economy and efficiency of fuel-gas manufacture, and amply justifies the description of a process that has made a successful and material advance in this direction.—The Editors.

URING the last few years there have been great developments in the production and application of gaseous fuel. Some of these are as yet hardly beyond the experimental stage, but others have passed into the stage of assured success, and therefore are of great interest to the fuel user. Amongst these latter may be placed the latest of all, the new method of producing water gas which bears the name of Messrs. Dellwik and Fleischer. Received at first with a considerable amount of incredulity, largely due to its very simplicity, the process was soon found to be a success not only on the experimental scale but on the larger scale of practical application, and this is the real test of the value of any invention.

Water Gas.—It has been long known that when steam is passed over red-hot carbon, in the form of charcoal or coke (preferably the latter for practical purposes, as it is much cheaper) decomposition takes place and a combustible gas of high heating power is produced, but knowing the fact and making it of practical utility are two very different things, and often very far apart. The chemical change which takes place is very simple. Water is a compound of the two gases hydrogen and oxygen, the former of these when free being highly combustible. When the water, in the form of steam, is passed over hot carbon, the carbon acts as a reducing agent, exactly as it does when it is used for the reduction of metallic oxides, takes up the oxygen to form carbon monoxide, and liberates the element with which the oxygen was previously combined, in this case hydrogen, and both the



THE DELLWIK-FLEISCHER WATER-GAS APPARATUS.

hydrogen liberated and the carbon monoxide formed are combustible gases.

The chemical reaction may be expressed by the equation $C + H_2O = CO + 2H$ or it may be put in words, thus: twelve pounds of carbon will act on eighteen pounds of steam, will liberate two pounds of hydrogen and form twenty-eight pounds of carbon monoxide, so that by weight the composition of the gas produced will be

Hydrogen	2	6.67 per cent
Carbon-monoxide	28	93.33 " "

Hydrogen is however much lighter than carbon monoxide and the composition of the gas by volume will be

Hydrogen	50 per cent
Carbon-monoxide	50 " "
	100

Such a gas therefore will be entirely combustible, and as hydrogen has a very high calorific power (about 52,000 BTU)* compared with that of carbon monoxide (about 4,300 BTU) the comparatively small quantity of hydrogen will have great influence on the heating power of the gas, which will be about 7,500 BTU per pound, or about three times as high as an ordinary producer gas.

A gas of so high heating power will obviously be very useful for many purposes, and naturally many attempts have been made to produce it, but the difficulties in the way of economical production are very considerable.

The chemical change takes place readily enough at a high temperature, but it slackens or ceases altogether if the temperature be allowed to fall, and the reaction itself absorbs a large quantity of heat. The reaction consists of two distinct parts. For each pound of carbon burnt there will be the formation of 2 1/2 pounds of carbon monoxide and the decomposition of 1 1/2 pounds of steam with the liberation of 1/6 of a pound of hydrogen. The union of 1 pound of carbon with 1 1/3 pounds of oxygen to form 2 1/3 pounds of carbon monoxide will evolve about 4,300 BTU of heat, but the separation of 1/6 of a pound of hydrogen from the oxygen with which it was combined in the water will absorb about 8,700 BTU so that calling these positive and negative respectively the balance sheet would be.

	BTU.
Heat evolved in the formation of 2 1/3 pounds of carbon monoxide	4,300 +
Heat absorbed in the liberation of 1/6 pound of hydrogen.	8,700 —
Balance of heat absorbed for each pound of carbon consumed	4,400 —

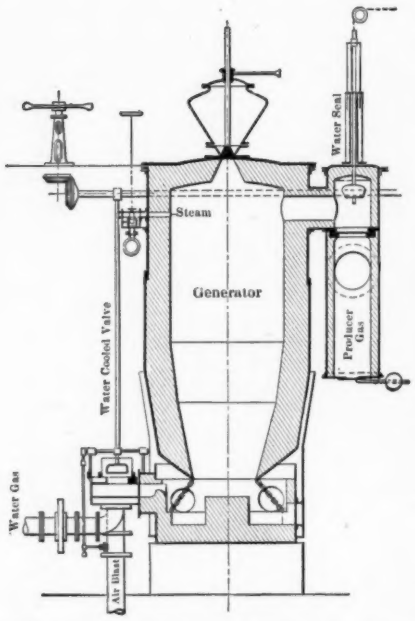
So that every pound of carbon consumed will absorb 4,400 units of heat, and if the reaction is to be kept going this must be supplied as well as heat to compensate for the various accidental losses, such as by radiation carried away in the gas and otherwise.

It is obvious that the necessary heat may be supplied in two ways.

1.—The decomposition may be carried out in a closed vessel heated externally, and in this case the gas production might be continuous. No method based in this principle has however been successfully applied.

2.—The temperature may be raised by blowing air into the gas producer, thus burning some of the fuel, and as soon as the

* Assuming the water formed to remain in the gaseous condition. The British Thermal Unit (BTU.) is the amount of heat required to raise 1 pound of water 1° F.



SECTIONAL DIAGRAM OF LOWE WATER-GAS PLANT.

temperature is high enough, cutting off the air supply and blowing in steam, usually in the reverse direction, the passage of the steam being continued till the temperature is reduced to a point at which the decomposition ceases or becomes slow, when the steam is cut off and air is again passed till the temperature is high enough. By this method the gas production must always be intermittent, periods of gas production alternating with periods of heating up. This is the method which has always been used in water-gas production.

History of Water Gas.—The date of the first attempt to make water gas for practical purpose is not known, but the first important patent seems to have been that of Lowe, taken out in 1875. Plant on the principle of this patent was soon created in America, in Great Britain, and on the Continent, and it came to be the recognised type of water-gas plant. The best known plant in Great Britain was probably that at the Leeds Forge though plant almost identical with this was erected in many other places.

It is an intermittent plant, heated by internal combustion, and consists of a cylindrical iron producer lined with fire-brick. Air is blown in and the water gas withdrawn at the bottom, the heating-up stage being therefore produced by an upward current of air whilst, steam being admitted at the top, the gas is made by a downward current of steam, the steam entering the coke where it is coolest and leaving where it is hottest.

Owing to the thick layer of fuel and the large excess of coke present, the combustion in the heating-up stage only takes place to carbon monoxide, so that the gas escaping during this stage consists

of carbon monoxide and nitrogen, and as it contains about 33 per cent. of the former gas, it is combustible and is a valuable fuel—indeed analyses of this "blow up" gas show it to be almost identical with producer gas made with only a small amount of steam. As the carbon is only burnt to carbon monoxide, the amount of heat evolved is small, and therefore a large amount of coke must be consumed in the heating up, and the heating up is slow—indeed, the usual rate is about 10 minutes heating up for four minutes gas making, and the yield of water gas is about 36,000 cubic feet per ton; roughly speaking, about two-thirds of the coke is burnt during the heating-up stage.

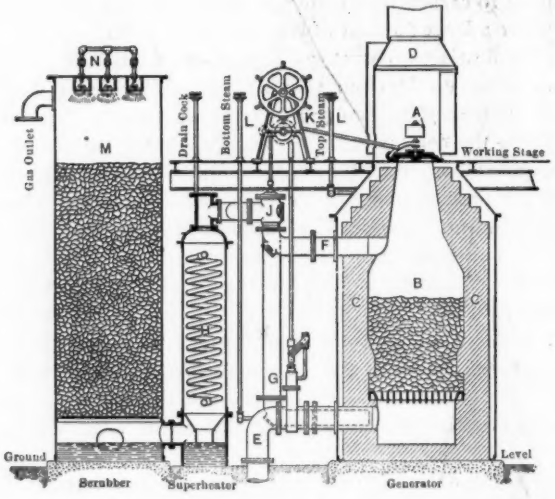
It is quite obvious that this consumption of fuel would heavily handicap the process unless the carbon-monoxide gas produced during the heating-up stage could be utilised in some way. Where this gas can be burnt direct in regenerative or other furnaces and the water gas passed into gas holders, the two gases being used separately, the process can be satisfactorily used, but in most cases this is not possible. Many attempts were made to modify the process in various ways, and Messrs. Loomis and Pettibone have an excellent apparatus, probably the best that can be designed on this principle, using the hot waste gases and also the sensible heat of the water gas for steam raising.

The radical defect of the usual type of intermittent, internal-combustion water-gas producer is the combustion of the coke during the heating-up stage to carbon monoxide only, thus utilising only about 4,300 units of heat for each pound of carbon consumed, and producing combustible gas which in many cases must be wasted. If the carbon could be burnt to carbon dioxide, each pound of carbon would evolve 14,540 units of heat, or rather more than three times as much as when burnt to carbon monoxide, and the escaping gases would only be useless products of combustion.

What was wanted, was evidently to burn the coke during the heating-up stage to carbon dioxide, and this Messrs. Dellwik and Fleischer succeeded in doing and thus made the production of water gas a practical success.

The Dellwik-Fleischer Process.—The conditions which must be arrived at when the production of carbon monoxide is desired, as in ordinary producer-gas making, are a thick layer of fuel, and therefore a large excess of carbon, and this is the condition in water-gas producers of the old type. Where carbon dioxide—i. e., complete combustion—is required, the conditions must be reversed, the excess of carbon must be small, and the thickness of the layer through which

the air has to penetrate small, so that the quantity of oxygen present may be in excess of that required to burn the carbon to carbon dioxide.



DIAGRAMMATIC REPRESENTATION OF DELLWIK-FLEISCHER WATER-GAS PLANT.

These are the conditions attained by Messrs. Dellwik and Fleischer in their process. There is nothing peculiar in their producer. In the first producers designed there were side chambers into which the fuel was fed, but these have been abandoned in the later installations and the producers are now circular iron chambers lined with fire-brick, about 8 feet in diameter and 10 or 12 feet high, the fuel being supported in the usual way on fire-bars beneath which the air is blown. The fuel is supplied at the top, but instead of the producer being filled with coke, only a thin layer rests upon the bars.

The results of these changes are little short of marvellous. The heating up stage is reduced to 2 or 3 minutes, whilst the gas-making blow is increased to 8 to 10 minutes, the production of water gas for each ton of coke is more than doubled and the consumption of coke in heating up is therefore reduced by one half.

The cause of these differences will be readily seen from the following comparative table. It is taken from Mr. Dellwik's paper read before the Iron and Steel Institute in 1900 but the figures have

been calculated into BTU from the centigrade results used in the paper.

C.	Old Method.	New Method.
1 lb. of C requires for combustion	To Co $\frac{16}{12}$ lbs. O	To Co_2 $\frac{32}{12}$ lbs. O
The O is accompanied by	4.32 lbs. N	8.64 lbs. N.
The products of combustion carry away at 1,260° F.	2045 BTU	3766 BTU
The heat of combustion of 1 lb. of C is	4,300	14,500
Balance available for heating fuel is	4300 — 2045 = 2255	14500 — 3766 = 10734
To make 30 lbs. of water gas, *i. e.*, to burn 12 lbs. of carbon, 51768 BTU will be required, therefore lbs. of C. must be consumed	$\frac{51768}{2255}$ = 22. 5 lbs.	$\frac{51768}{10736}$ = 4. 8 lbs.
Apart from loss by radiation, etc., there will be required for making 30 lbs. (753 cu. ft.) of water gas	12 + 22.5 = 34.5 lbs. C.	12 + 4.8 = 16.8 lb. C.
Or per lb. of C. is produced ...	21.7 cu. ft. water gas.	44.7 cu. ft. water gas.
As water gas of theoretical composition contains 290 BTU per cubic foot, there is utilised in water gas from 1 lb. C.	6293 BTU	12963 BTU
Which is equal to	48 per cent, of the total heat of the carbon.	92.5 per cent. of the total heat of the carbon.

These figures are quite near enough to form a basis of comparison, though they cannot be taken as being absolutely correct; for instance, the gas will probably leave the producer at a lower temperature during the heating-up stage under the old process than under the new, and on the other hand, the heating-up stage being much shorter, the loss by radiation should be less during the new process than the old. At any rate, the main features of the new method are sufficiently well marked: the quantity of water gas obtained per pound of fuel is about double, and the heating power of the gas from a given weight of fuel will also, therefore, be much larger; there is no loss

of combustible gas, the products of combustion being quite valueless except for the serviceable heat which they carry away, which no doubt if found advisable might be utilised for steam raising as in the Loomis-Pettibone plant, or in some other way.

It may be remarked that the efficiency as shown in the table—that is, the proportion of the heating power of the fuel which can be obtained by the combustion of the gas—is larger than by any other process of fuel-gas making. In ordinary gas producers the efficiency calculated on similar lines is usually about 80 per cent.

Practical tests do not, of course, give as high an efficiency, because certain sources of loss are not taken into account in the calculations, but these are much the same in all gas producers. Practical tests quoted by Mr. Dellwik in his paper give efficiencies from 75.2 to 81.3 per cent.

A certain quanity of fuel will of course be required to raise steam, and this may be taken as about 1/5 of that used in the producer, but this might perhaps be reduced by using the sensible heat of the gas for steam raising or heating the boiler water.

Mr. Dellwik quotes some experiments of Prof. V. B. Lewes.

> "1,000 cubic feet of water gas, containing 15 pounds of carbon, are obtained by a total expenditure of 29 pounds of carbon, so that over 51 per cent. of the carbon is obtained in the gaseous form, whilst the expenditure of the other 49 per cent. results in the hydrogen of the water gas.
>
> "The coke used in the experiments made contained 87.56 per cent. of carbon, or 1,961.3 pounds per ton, equal to 15,876,307 thermal units C.° (28,577,352 BTU), and this amount yielded 77,241 cubic feet of water gas. The specific gravity, as taken by the Lux balance, was .5365, and its gross calorific value as determined by Junkers calorimeter was 4,089 thermal units (7,360.2 BTU). Hence the calorific value of the water gas from a ton of coke was 13,033,059.8 thermal units (23,459,507.2 BTU), or over 82 per cent. of the heating value of the total coke used in both generator and boiler.
>
> "From this calculation 20 per cent. of the coke has been taken as used for raising steam, but in a large installation this figure could be reduced and the percentage of the total heating value of the coke obtained in the gas slightly raised. The labour will be less than with the ordinary process, as less fuel has to be handled."

The water gas produced by any process is of course not of quite as good a quality as that shown by theory, because the temperature falls towards the end of the process and thus a small amount of carbon dioxide may be added to the gas, and also the producer at the moment of reversal is filled with gas consisting of carbon dioxide and nitrogen

which is thus mixed with the producer gas. This, however, slightly increases its volume and does not to any considerable extent lessen its value.

The following analysis of water gas is given by Mr. Dellwik and will give an idea of its composition in practice.

Hydrogen	51	per cent.
Carbon monoxide	42	" "
Marsh gas	.5	" "
Carbon dioxide	4.0	" "
Nitrogen	2.5	" "

so that 93.5 per cent. of the gas is combustible. The gas burns with a non-luminous blue flame, whence it is called "blue gas," and the flame has a very high temperature.

The plant required is comparatively simple. The producer is circular and of the bar bottom type and is charged at the top by means of suitable iron trucks, about 2 cwt. of coke being added at a time. The producer is so arranged that the steam can be blown in and the gas drawn off either above or below the fuel, and in practice it is worked alternately in each direction, as this is found to give more uniform heating. The gas is passed to a gas holder, this being always necessary in the case of intermittent methods of gas production, and the products of combustion during the heating stage are allowed to escape.

An ingenious system of valves is used so as to make it impossible to open the air supply whilst the producer is in connection with the gas holder. The progress of the gas making is watched by burning a small jet of the blue gas at a burner on the top of the producer, and this gives instant indication of the slackening of the decomposition of the steam, which is the signal for stopping gas production and heating up again.

Water gas can be used for any purpose for which gaseous fuel is required, though it is perhaps too much to say that it is best suited for all, but certainly in all cases where a very high temperature is required is unsurpassed.

Owing to the non-luminosity of the flame of water gas, it cannot be used directly for illuminating purposes, but it can be used quite readily and strange to say this seems to be one of the most promising fields for the use of the gas.

In the early days of water-gas making it was used by making the non-luminous flame heat mantles or combs of magnesia, and

whilst the light given was in many ways excellent the friability of the combs militated against its success.

In ordinary coal gas, however, the illuminating constituents are present only in small quantity, the larger proportion being carbon monoxide and hydrogen, but in somewhat different proportions from those in which they are present in water gas. Indeed, a high heating power is essential to a good illuminating gas, as the separated carbon to which the flame owes its luminosity must be heated to a high temperature, in order to obtain high luminosity.

Prof. Lewes has devised a process of using water-gas in conjunction with coal gas by passing the former through the retorts, and this has been tried at Tipton Staff with great success. The figures given by Mr. Hills of a test made on February 27, 1903, are of great interest; not only is water gas made from the coke, but the actual yield of gas by distillation is increased.

Coal carbonised	31.07 tons
Total purified gas made	528,000 Cu. ft.
Total crude water gas made	144,000 " "
Make per ton, deducting water gas	12,359 " "
Make per ton, including water gas	16,993 " "
Water gas added, per cent.	37.5
Water gas in mixture, per cent.	27.2
Illuminating power unenriched	11.43
Candle feet per ton	37,826
Calories per cubic feet, gross	130.5
Calories per cubic foot, nett	111.8

One week's working gave

Coal carbonised	196 tons.
Total purified gas made	2,869,000 Cu. ft.
Total water gas added	459,000 " "
Make per ton, deducting water gas	12,295 " "
Make per ton, including water gas	14,635 " "
Water gas added, per cent.	19.05 " "
Water gas in mixture, per cent.	17.05 " "
Illuminating power (enriched	15.40
Gallons of benzol added, per 1,000 cubic feet	0.81

The cost for the blue water gas into holder is given as

	d.
Labour	0.68
Coke for generator	2.20
Fuel for boiler	.39
	3.27

and the make per ton of coke is about 60,000 cubic feet. Water gas is also being used satisfactorily in conjunction with the Peebles oil-gas process, the water gas and the oil gas being mixed in suitable proportions.

For certain purposes the non-luminosity may be a disadvantage, but this is so easily got over by carburisation that it is of little moment; but the high heating power of the gas in comparison with ordinary producer gas may in some cases necessitate changes in the details of the methods of using. The quantity of air required for combustion is of course very much larger than for ordinary producer gas, so that for combustion in regenerative plant the sizes of the regenerators and ports would have to be rearranged; but it does not seem that there should be any difficulty in using the gas for any purpose for which producer gas can be used.

Owing to the large percentage of carbon monoxide present, the gas is very poisonous; and as it is odourless, an escape cannot be readily detected, and in the early days of its use several accidents happened. In ordinary use as a fuel this is of little moment. It would be an objection for domestic use, but it is hardly likely to be used for lighting except in admixture with other gases, and if required an odour—as unpleasant as may be required—is easily imparted to it.

One objection often urged against water gas is that it cannot be made from the cheap coals usually used in gas producers of the ordinary type. At present this is of little moment, for coal gas is made on such a large scale that coke is obtainable at a reasonable price, but even if it were much dearer than it is now, water gas could still be made economically.

Very little has been done in the way of the recovery of by-products from gas producers, nor is it likely to be except in very large installations; and in the production of gas and coke by direct distillation the by-products can be recovered much more economically than from gas producers.

The gas is clean, free from tarry matters, and the sulphur will always be present as hydrogen sulphide, which is very easily removed.

On the whole, the process of Messrs. Dellwik and Fleischer has a great future. It seems to be the greatest advance in the production of fuel gas that has been made since the introduction of producer gas, and it well merits the attention of all users of fuel gas.

SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIREBOXES.

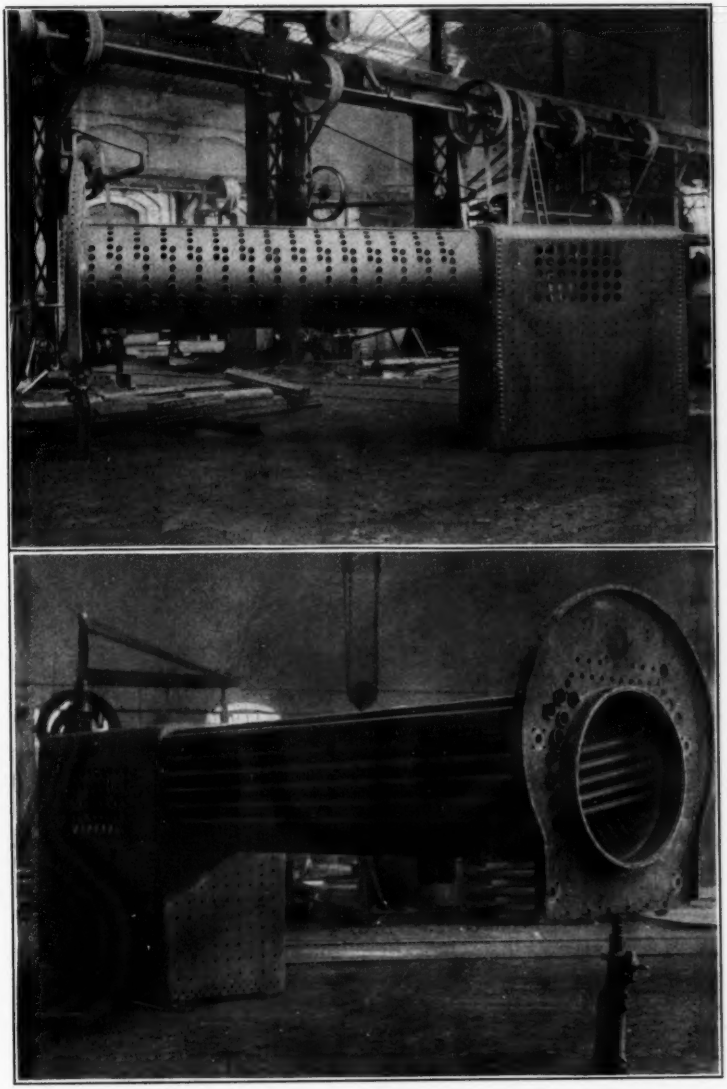
By Chas. S. Lake.

It was pointed out, in introducing Mr. Lake's first article to the readers of our October number, that locomotive practice embodied results of the utmost significance to steam engineering in all its branches, because the conditions of railway working had forced the locomotive designer to the limit of "intensified production" of steam power. His creations, therefore, represent the ultimate of the tendencies which are growing more and more apparent and the requirements which are growing more and more insistent in every stationary power plant. And this is most strikingly true of British practice because of the very close limitations imposed by the loading gauge of the British railways. In the present paper Mr. Lake concludes his review of the late work of the British engineers, and in a concluding article next month he will touch upon the most salient features of recent Continental and American practice.—The Editors.

N the early part of 1899 Mr. Dugald Drummond, the able locomotive superintendent of the London and South Western Railway, introduced a new pattern of firebox containing two groups of transverse water tubes, so arranged as to be easily accessible without having to dismantle the engine, or take it under the shear legs for the purpose of lifting the boiler.

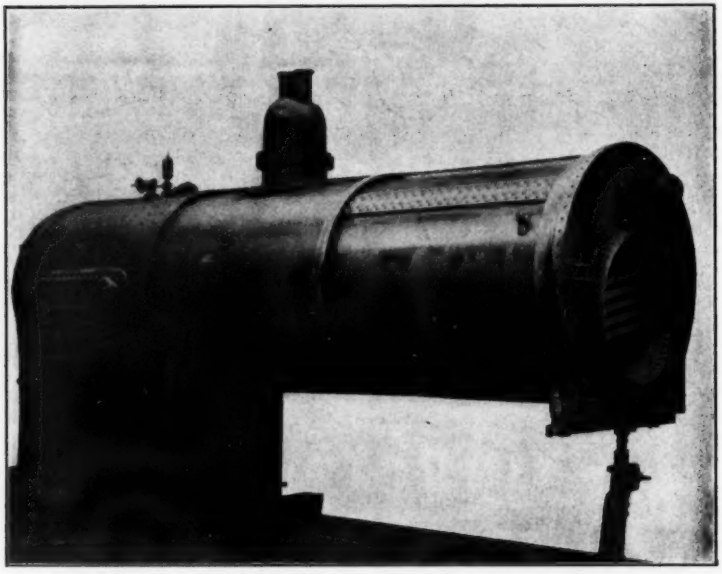
This is effected by means of providing two virtually rectangular apertures on either side of the outer firebox shell. A forged ring is rivetted on around each of these apertures and is faced to receive a door which, as will be seen in the figures, is held in position when open by two hinges attached to the aforesaid ring. A red-lead joint is provided between the face and the door and the two are pulled up tightly together by means of bolts and nuts placed all round the outside of the faced joint.

A neat wrought-iron cover, which can easily be detached in a few moments, conceals these doors, and thus constitutes the only difference (so far as outward appearance is concerned) between the engines which are fitted with the special fireboxes and those which are not. The water tubes, which are 2⅛ inches outside diameter, number 61 collectively, 25 being in the forward group and 36 in the other, the total heating surface obtained from them being 165 square feet. Those in the forward group are inclined in a downward direction towards the right-hand side of the engine and those in the rear group towards the



DRUMMOND'S WATER-TUBE BOILER, FIRST AND SECOND STAGES OF CONSTRUCTION.

left hand, (presuming that one is looking in the direction of the smoke-box.) This is done with a view to promoting a good circulaton of the water. The inside firebox is of copper, and is stayed (in that portion occupied by the cross tubes) by means of long stay rods which pass through the tubes and are secured to the inspection doors by means of thimbles.



DRUMMOND'S WATER-TUBE BOILER, FINAL STAGE OF CONSTRUCTION.

The water tubes are of steel, solid drawn, expanded in the firebox plates and beaded over outside. The walls and crown of the firebox provide 148 square feet of heating surface which, added to the 165 contributed by the transverse tubes, brings the total for the firebox up to 313 square feet, a very material advance over the area usually obtained from this source.

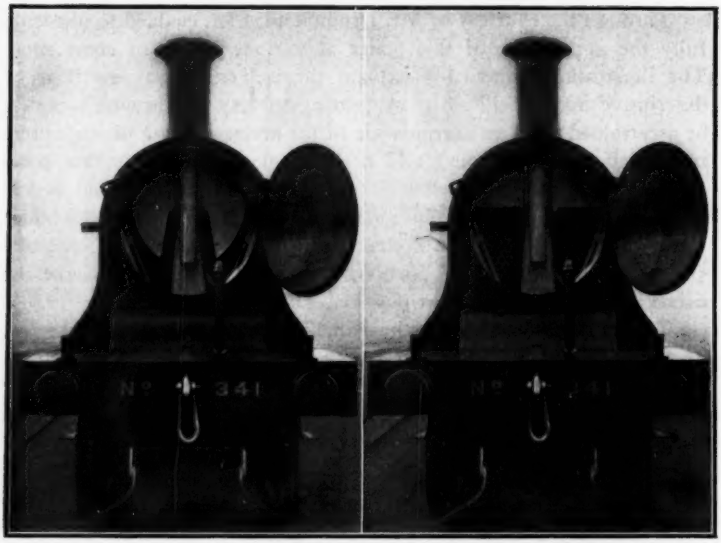
Having satisfied himself that the application of his invention to the fireboxes of locomotives resulted in their efficiency being increased, Mr. Drummond decided upon extending the sphere of his operations, and his next step was to design a water-tube boiler, in which as will be seen, he almost entirely dispenses with fire tubes, there being only 18 of these whilst no less than 215 water tubes are provided in the boiler and 40 more in the firebox.

Through the courtesy of Mr. Drummond, I am enabled to illustrate fully the appearance of this boiler at various stages of completion. The illustrations practically explain themselves, but a few lines of descriptive matter will assist in clearing up any points which cannot be ascertained from an examination of the accompanying photographic reproductions. The boiler and firebox, taken collectively, are comprised of four integral parts which may be briefly summarised as follows: (1) The cylindrical flue; (2) the inside firebox; (3) the boiler shell; and (4) the outside firebox. The upper picture on page 217 shows the two first-named portions ready, but for the absence of the firebox tubes, for placing in position.

The flue is 2 feet 9 inches in diameter and provides 86 square feet of area for heating purposes. The total heating surface from all sources is 736 square feet. The flue tubes (as can be plainly seen by referring to the pictures) are placed in a transverse position and at an angle of inclination, with the same object as in the case of the water-tube firebox previously described, viz; that of facilitating circulation of the water.

The present firebox contains 40 water tubes. These pass right through from one side of the outer shell to the other, connecting the intervening spaces between the inner and outer fireboxes. The longitudinal fire tubes are really of more value as stays than as contributors to the heating surface of the boiler. The greater volume of the furnace gases, as is only naturally to be supposed, passes through the flue and among the water tubes, only a small percentage of the products of combustion finding its way via the longitudinal tubes into the smokebox. The major proportion, having entered the flue at a very high temperature direct from the furnace, is thoroughly mixed without being immediately cooled below combustion point. The flue water tubes, by virtue of the manner in which they are arranged, present an obstruction to anything like rapid transit on the part of the gases on their way from the furnace to the smokebox, and the effect of this impedimental influence is to bring about a more perfect combustion of these gases, with the result that by the time that they are finally delivered into the smokebox they have been divested of practically all their heating value, which has been transmitted to, and absorbed by, the water in such a thoroughly effective manner that the evaporative capacity of the boiler is considerably higher than is the case with the ordinary fire-tube pattern, although the dimensions in both cases are similar in all respects.

Mr. Drummond has given a great deal of attention to the subject of what is known in railway phraseology as "sparking." There are

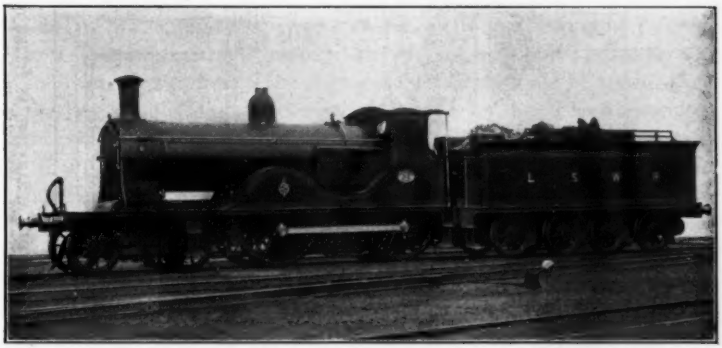


DRUMMOND'S SPARK PREVENTER AND FUEL ECONOMISER.
Left, running position; right, movable wings lifted for access to boiler tubes.

already a number of devices in use known as spark arresters, few of which however can be said to be really efficient for their purpose. It is no uncommon thing to read, in the course of evidence given in courts of law where claims for compensation for loss of property by fire, (alleged to be attributable to sparks thrown from the chimney of a locomotive) are the cause of litigation, that the offending engine was fitted with a "spark arrester" and the details of the appliance are, in the majority of instances, described in detail by the railway company's officials for the guidance of counsel and the presiding judge or magistrate. The point usually turns upon whether it can be proved that all reasonable precaution was taken to prevent the undue emission of red-hot cinders from the stack of the locomotive, and the verdict not unfrequently goes to the defendant company on the ground, that the apparatus fitted was "sufficient" to effect its purpose, and that the evidence was not sufficiently conclusive to prove that the origin of the destruction could be traced to lack of precaution on the part of the railway authorities, who, on their side, usually have something to say about "contributory negligence" in cases where the responsibility for the mischief has been brought home to them in an unmistakeable manner.

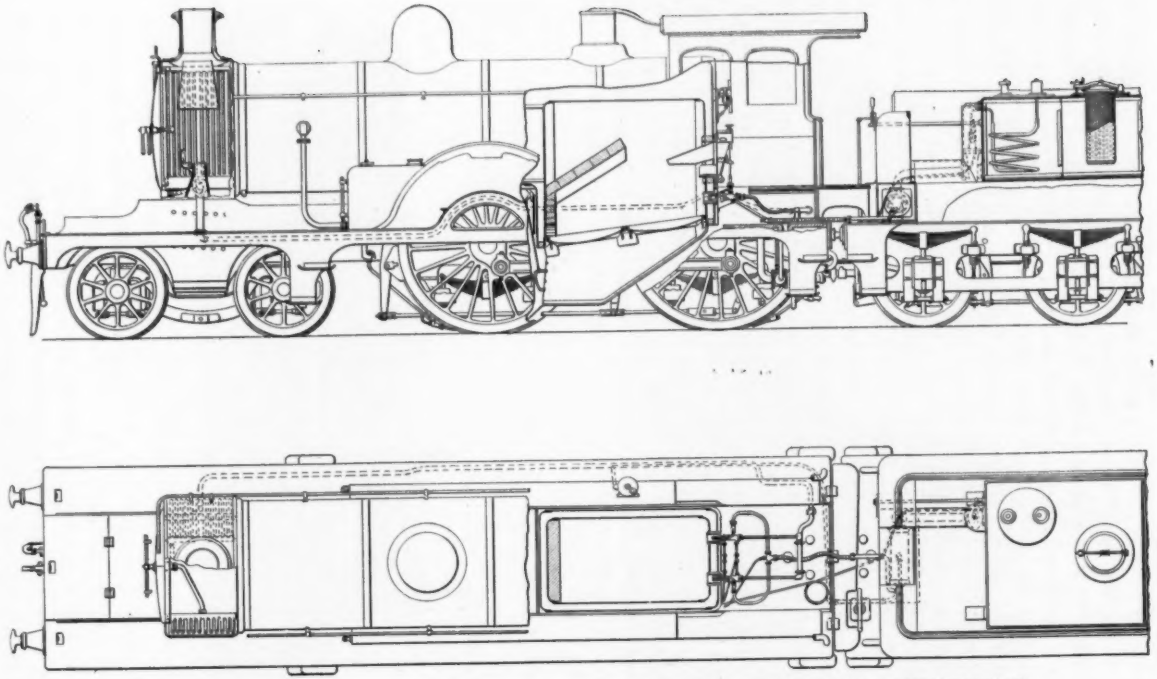
There is another aspect of the spark-throwing nuisance which con-

cerns the railway companies alone, and that is the waste of fuel which is occasioned by wholesale sparking; and with the object of securing feedom from this objectionable feature Mr. Drummond has brought out a combined spark preventor and fuel economiser, which is illustrated by the pictures opposite. This device has given quite the best results of any arrangement which has been tried up to the present. The methods of construction and operation are as follows: Attached to the cap of the exhaust pipe by means of bolts and nuts are two fixed wings of fan-like shape, which form what is virtually a chamber. The exhaust blast pipe instead of leading direct from the smokebox passes into an extension which projects downwards from the chimney into the smokebox. At the sides of this extension two slotted holes are provided. These communicate with the chamber formed by the two fixed wings, to which are attached two moveable wings, which swivel on a pin (thereby enabling them to be folded up over the fixed wings) when it is required to gain access to the boiler tubes. The furnace gases, upon reaching the smokebox, pass first through the end of the moveable-wing chambers, next through the fixed-wing chambers and finally by way of the slotted holes referred to up the chimney in the usual manner. The nozzle of the blast pipe is above the level of the boiler shell and extends a few inches into the chimney proper. An equal draught



STANDARD 4-COUPLED EXPRESS ENGINE WITH WATER-TUBE FIREBOX AND SPARK PREVENTER, LONDON & SOUTH WESTERN RAILWAY.

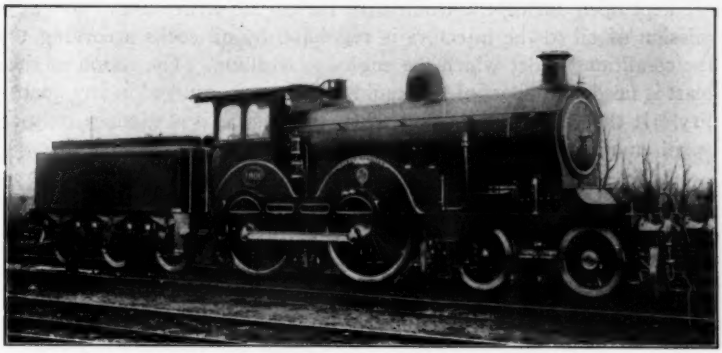
through all the boiler tubes is obtained as a consequence of employing this arrangement, and the few hot cinders which find their way into the smokebox are deposited there and remain until it is convenient for them to be removed. Experiments with this apparatus have proved that an *average* saving of 5 pounds of coal per mile is effected by its



HOLDEN'S LIQUID-FUEL APPARATUS, AS FITTED TO EXPRESS PASSENGER ENGINES, GREAT EASTERN RAILWAY.

use—a very considerable item in the expenses of a large railway company.

The Great Eastern Railway Company have a large number of locomotives in operation which are fitted with the necessary apparatus for burning liquid fuel. Mr. James Holden, the locomotive superintendent of the line in question, is the patentee of the oil-fuel system which bears his name.



THE CLAUD HAMILTON, LIQUID-FUEL-BURNING EXPRESS LOCOMOTIVE, J. HOLDEN'S SYSTEM.

The principle of this system can be easily understood by reference to the drawings (kindly supplied by Mr. Holden) which accompany the following description. The engine shown is, it should be stated, one of the large bogie express locomotives known as the "Claud Hamilton" or exhibition type—in fact the drawing, as will be seen, represents the "Claud Hamilton" itself, the pioneer of the type and one of the few purely British locomotives exhibited at the Paris Expositon of 1900.

The liquid fuel is contained in a tank of 500-gallons capacity which is carried upon the tender. Two pipes connect this tank with a couple of injectors which are placed in specially prepared orifices in the firebox plates 12 inches above the bars. After a considerable amount of experimenting it has been found that at this height the best results can be obtained.

The fire bars are of the ordinary pattern, as indeed is the entire construction of the firebox. A layer of broken fire bricks is spread upon the bars to a depth of 9 inches at the back, under the burners, 4 inches in the centre, and 6 inches in front. A small coal fire is made up on the centre of the bars and is kept alive without having recourse to the liquid fuel until it is required to start the train. Then the injectors

are brought into use and deliver the oil in the form of spray upon the coal fire, the result being to produce, in a very short space of time, an intense heat which can be easily maintained by means of further spray injections as occasion demands.

Steam is employed as the propelling agent in the spraying operation. The steam mingles with the oil and sets up a strong induced current of air though the central air tubes of the injectors. The steam cocks are kept open during the whole time the engine is working. The admission of oil to the injectors is regulated by oil cocks according to the conditions under which the engine is working. The action of the blast is needed to allow of the liquid fuel being consumed in any quantity. It therefore follows that when the engine is stationary only a small amount can be used.

A bell-shaped orifice is provided at the bottom of the smokebox, and through this a supply of air enters, and, after passing through a number of small pipes running round the inside of the smokebox, is conveyed by means of a larger pipe to the injectors. By this means the temperature of the air is raised, to such an extent that by the time it reaches the injectors it is about 400 degrees F. The liquid fuel is delivered to the injectors at 200 and the steam at 250 degrees F. The air-inducing rings are of a modified form in the later engines of Mr. Holden's design. As a result of these modifications a greater amount of efficiency in atomising and distributing the oil fuel has been obtained.

If any difficulty should be met with in keeping up a sufficient head of steam when the engine is on heavy duty, or is not, for any reason, steaming well, a thin coal fire is sometimes used over the broken bricks, but it is only on very rare occasions that this expedient is resorted to.

The four principal ingredients of which the liquid fuel is composed are oil, coal-gas tars, creosote oils and petroleum residues. The value, as a heating agent, of any of the component substances mentioned, is nearly twice that of coal, provided of course that they be of good quality. The higher calorific value of the fuel, taken in conjunction with its great portability, form a strong combination of points in its favour.

The extra expense entailed in fitting the apparatus must of course be set against the many advantages which accrue from its use, but even then a substantial margin of gain is assured in the long run.

The first really successful engine adapted to the use of liquid fuel was the "Petrolea" built in 1890. During the whole of the period represented by the intervening years Mr. Holden has been indefatig-

able in improving his system, by means of experiments and exhaustive observations, and the net result of his labours is to be seen in the highly proficient stage to which he has brought this important branch of engineering development, for which he is justly considered as one of the most able authorities upon the subject of steam generation.

Before bringing that section of this article which deals with British practice to a conclusion, reference must be made to the highly interesting and important experiments which are being carried out by Mr. H. A. Hoy upon the Lancashire and Yorkshire Railway, with a locomotive fitted with a cylindrical corrugated firebox. The idea of adapting this pattern of firebox to locomotives is not by any means a new one, neither is it confined to Great Britain. In America cylindrical fireboxes are being used with good results, but Mr. Hoy is the first engineer to introduce them upon any of the English main lines. The locomotive selected for testing the value of this latest departure from regular practice is an eight-coupled mineral engine built at the company's works at Horwich in 1902.

The principal advantage claimed for fireboxes constructed upon this plan are briefly as follows

1.—A free circulating area

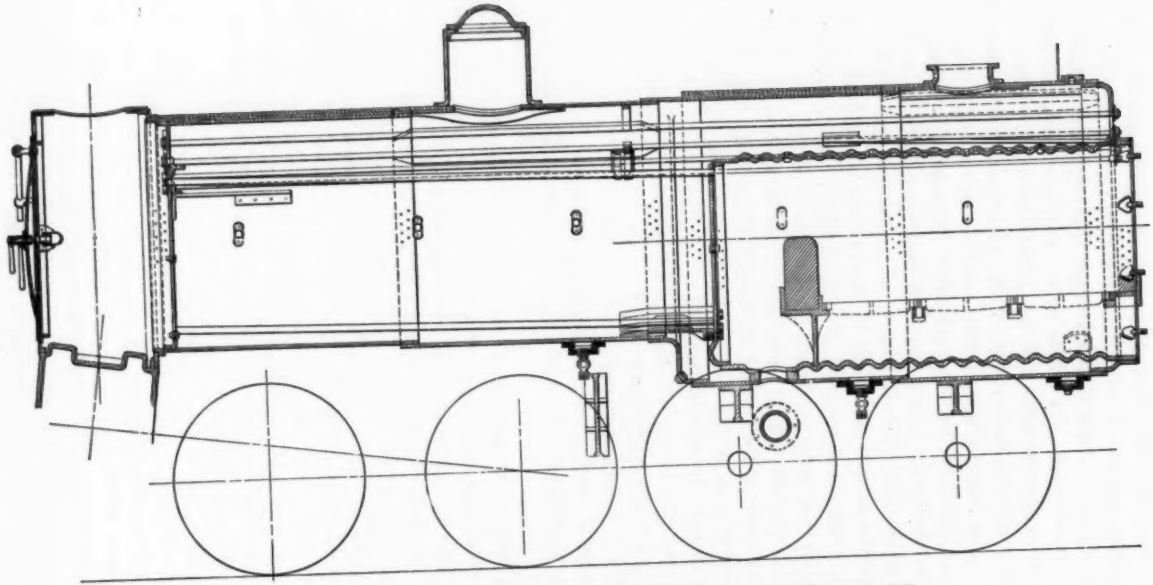
2.—General simplification of construction

3.—Avoidance of the necessity for using screwed stays and a copper firebox.

There are also other points in favour of the innovation which could be urged on theoretical grounds, but it remains to be seen whether any or all of these will be realised under actual working conditions.

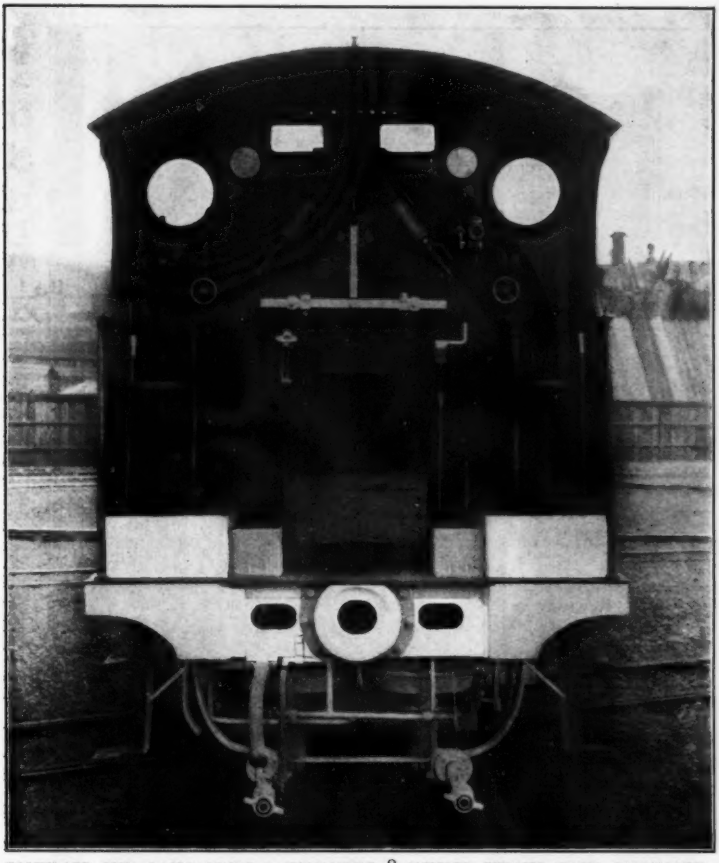
In the particular engine under notice the barrel of the boiler is 12 feet 3½ inches long and has the very large diameter of 5 feet 4 inches inside its smallest ring. The shell of the firebox is 6 feet 9¾ inches diameter inside, and the firebox itself takes the form of a cylindrical corrugated flue, 9 feet 11½ inches in length and 5 feet 1½ inches diameter outside. The corrugations are 1½ inches in depth, the ribs having their centres spaced at 6 inches apart. The material used is steel, ¾ inch in thickness.

The crown of the firebox shell rests on the top of the boiler barrel owing to its centre line being 5¼ inches below that of the barrel. The centre line of the corrugated flue is lower again by 7⅛ inches than that of the firebox shell. Further particulars can be gathered from the drawings. The extreme length of the firebox would lead one to suppose that difficulty would be experienced in properly firing it, but the men who are employed to run the engine distinctly state that such is not the case.



LOCOMOTIVE WITH CORRUGATED FIREBOX, LANCASHIRE & YORKSHIRE RAILWAY.

By courtesy of *The Engineer*.

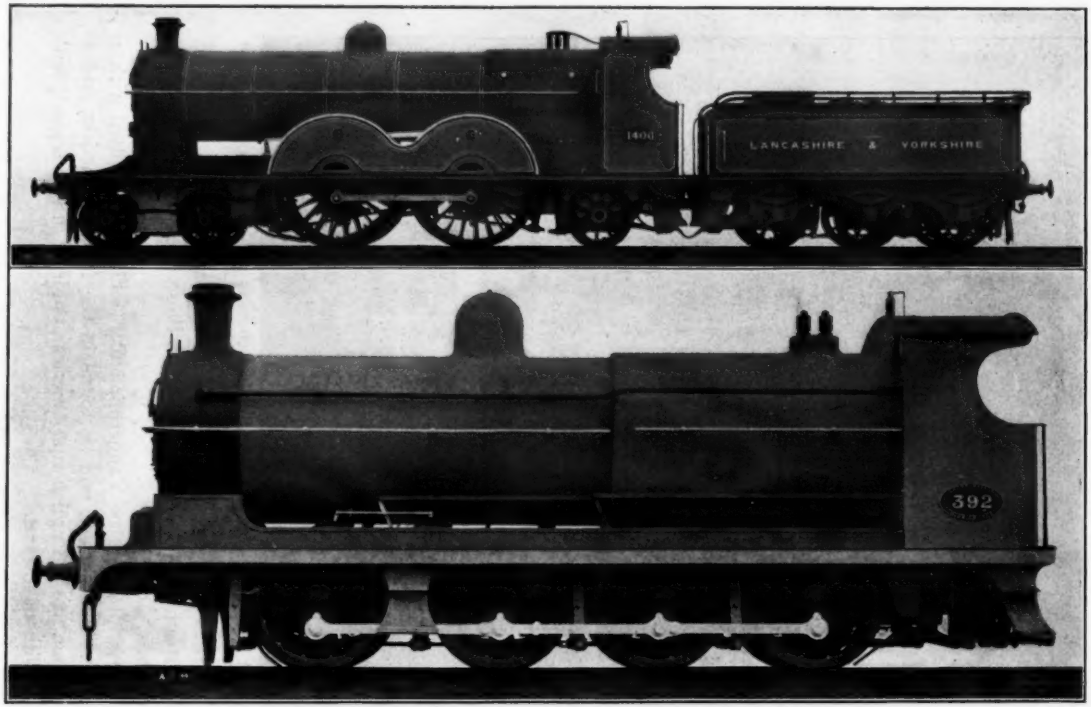


FOOTPLATE END, LANCASHIRE & YORKSHIRE 8-COUPLED ENGINE WITH CORRUGATED FIREBOX.

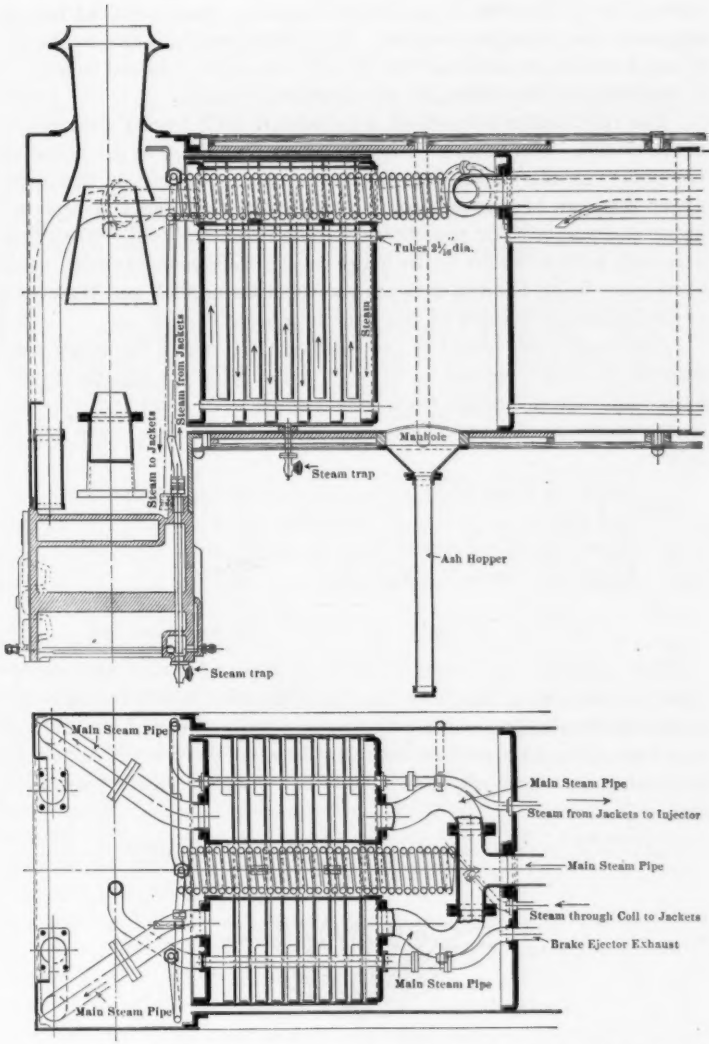
They further assert that it is a much easier matter to keep up a good head of steam with this engine than with those fitted with the ordinary pattern box.

A description of the Vanderbilt boiler, which is also fitted with a cylindrical flue firebox, will be found in the following article, and a comparison of the English and American engines, in this respect, will not be without interest.

One of the large express engines of the "1400" class designed by Mr. Aspinall in 1900 for the Lancashire and Yorkshire Railway is



Above is the Lancashire & Yorkshire 10-wheeled Express Engine; weight 58 tons 15 cwt., cylinders 19 by 26, drivers 7 ft. 3 in., 1877 ft. tube surface, 175.8 ft. firebox, 26.05 ft. grate. Below is the 8-wheels coupled goods engine of the same road; weight 57 tons 18 cwt., cylinders 20 by 26, 1882 ft. tube surface, 135 ft. firebox, 33 ft. grate.



SUPERHEATER FITTED TO LANCASHIRE & YORKSHIRE 10-WHEELED EXPRESS LOCOMOTIVE.

fitted with a superheater.* This is placed in the smokebox, which is of unusual length in order to provide the necessary space required for the apparatus and its appurtenances. The added length of the smokebox is not, however, noticeable from the outside, as the forward tube plate is recessed into the boiler, for the necessary distance.

The superheater consists of a cylindrical shell having tube plates at either end. The tubes are slightly larger than those in the barrel of the boiler, so that when it is necessary to remove any of the latter group they can be drawn through the superheater tubes and replaced in the same way. The superheater can be taken out bodily when it is necessary to have access to the boiler tubes for extensive repairs, sufficient space being allowed between the superheater shell and the inside of the smokebox to allow of this operation being carried out.

Diaphragms are placed in the superheater to make the steam pass through its entire volume on its way to the cylinders and the superheater tubes pass through these diaphragms. The total area exposed to the steam in the superheater is 439.49 square feet made up as follows.

Inside of band plate	40.63	square feet
End plates	29.48	" "
Tubes (outside diameter)	360.26	" "
Jacket coil (outside diameter)	9.12	" "
Total	439.49	square feet

The value of superheated steam is clearly understood and appreciated by engineers, and now that the difficulties which formerly attended the lubrication of the cylinders and the packing of the stuffing boxes have been almost if not entirely overcome, there would appear to be no adequate reason why it should not be more generally employed for locomotives.

* Quite recently two more of these engines have had superheaters added.

SOME SOURCES OF ERROR IN WATER TREATMENT.

By H. Spencer Flynt.

Mr. Flynt's admirably clear explanation of the methods of water purification and the difficulties and mistakes to be avoided will be of great service both to those who are using and those who are introducing sound systems of water softening for industrial or domestic purposes.—The Editors.

BEFORE entering into consideration of this subject it will perhaps be not out of place to touch upon the general causes of hardness in natural waters and the most practical methods that have been adopted to remove this trouble, as doubtless there are many interested in the matter who are not familiar with the chemistry of water purification.

Rain water, while percolating through the ground to find its level in the surface or deep streams, picks up a large quantity of carbonic acid, by the presence of which the chalk (carbonate of lime), magnesian limestone, (chalk and carbonate of magnesia), ironstone, soda, potash, and a few other compounds are enabled to dissolve, and are held delicately and unstably in solution as bicarbonates. To illustrate this state of combination in formulae let us take chalk for example. This is calcium oxide (CaO) combined with carbon dioxide (CO_2) and is the monocarbonate of lime, almost insoluble in water. But let it come in contact with a water highly charged with carbon dioxide, a water that is in reality a solution of carbonic acid (H_2CO_3), and the chalk is dissolved, and will remain dissolved so long as the carbonic acid is present in sufficient quantity. The combination now takes the formula CaO. $(CO_2)_2 + CO_2$, or calcium oxide combined with two molecules of carbon dioxide and held in this delicate state of combination by the free CO_2.

Now the fundamental operation in the softening of waters hard from this cause is to remove the excess CO_2 by the addition of some substance with which it readily combines, and preferably one that forms an insoluble, or only very slightly soluble, compound. Quick lime (calcium oxide), when carefully dealt with, is the best of these on account of its cheapness and splendid efficiency. The quantity of excess CO_2 in the hard water is determined by analysis, and from the

result the required amount of calcium oxide is calculated to completely satisfy this in the process of forming chalk. The lime is added to the water in the form of milk of lime of known strength, and what might be termed the beautiful part of the reaction is the double transformation that takes place. The newly added milk of lime not only becomes insoluble chalk by combination with the carbon dioxide, but reduces the bicarbonates of lime and magnesia to the insoluble monocarbonates, and all three fall together in the form of a heavy and rapidly clearing precipitate. The reaction with regard to iron differs from the two former in this respect, that the bicarbonate of iron when robbed of its carbon dioxide is reduced for a moment to ferrous oxide, which, in turn, goes rapidly through the process of combining with more oxygen to form ferric oxide and falls with the chalk and magnesium carbonates in the form of red rust, the supernatant water remaining perfectly clear and soft. The potash and soda, of course, remain dissolved, but are not in any way harmful if present in only small quantities.

Superficially considered, the softening of large supplies of hard water for various purposes—steam raising, laundry work, domestic use, etc.—would appear to be one of the simplest and safest processes in chemical engineering—a process offering special success to the application of automatic apparatus. But this is true only under certain conditions, and it is the purpose here to point out where those conditions often fail. I do not wish to criticise or cast reflexions upon any of the numerous softening plants now upon the market. Many of them are ingenious in their simplicity and most are efficient when properly managed. But no process can be automatic and remain continuously efficient when some of the conditions are inconstant quantities. The reagents employed are inconstant in their proportion of real active substance, especially lime; the man who does not know how to weigh accurately or believes in the virtues of the "bit extra for luck" is perhaps the most dangerous of the inconstant quantities; the water itself sometimes varies a little with the atmospheric temperature, and, if deep well water, it alters considerably when drawn to the surface and exposed for any length of time. Under varying conditions of this kind, sometimes coupled to gross carelessness on the part of a man in charge who knows nothing of the theory of the undertaking, it is not surprising that automatic water-softening plants of really excellent design often fail to do the guaranteed duty and are condemned.

After analysis of a given sample of water, the manufacturer of a

purifying plant guarantees to treat the supply from which it was taken in such a manner as to bring it down to some stated low degree of hardness, and so long as the value of the chemicals used, in actual reacting substance, is known and the plant kept in good condition—i. e., all leading and discharge pipes free from choking by precipitated matter or incrusted milk of lime; kept, in short, of sufficient area to maintain a given flow—this low degree of hardness may be confidently ensured.

It is after the manufacturer has finished supervising the plant and explaining away perplexing circumstances that troubles may arise. In the hands of the ignorant there are two sources from which difficulties may occur with a water-softening plant, *under-treatment* and *over-treatment.* The latter, though perhaps transforming a rusty or cloudy water to a clear and sparkling one, to all outward appearances pure, may make it considerably worse, especially for boiler and laundry purposes, than it was originally. Even if the man in charge is instructed in the determination of the extent of over-treatment by use of phenolphthalein and a standard acid, the only thing he can do is to under-treat a subsequent volume of water in such a manner that neutrality will result when the two volumes are mixed. But this course must necessarily bring about secondary precipitation in the reservoir or pipes, and if resorted to at all frequently will cause the water to be more or less opaque owing to fine particles in suspension that have come into being *beyond the filter,* and therefore cannot be removed without a great waste of time in settlement and careful decantation.

Where caustic soda alone is used as the reagent, the danger of error from either of these causes is considerably reduced, for the reason that caustic soda containing a constant and guaranteed percentage of sodium oxide is readily to be obtained in the open market. But apart from the fact that this is about twice as expensive as the lime or lime and soda ash methods, it is applicable to industrial purposes only and cannot be employed in the treatment of towns' water or private drinking water supplies. Caustic soda, however, is a compound that is not to be trusted implicitly unless it is carefully dealt with. If the supply is kept on stock it should be kept water-tight, air-tight, and free from carbonic acid gas. It absorbs water, even from the atmosphere, with wonderful rapidity, altering its weight accordingly, and if in contact with CO_2 gas is changed at once to carbonate of soda and is no longer capable of softening waters that are hard (as most waters are) by reason of their dissolved CO_2 and bicarbonates of lime and magnesia. I have known many mistakes of this kind to occur through the

ignorance—not blameworthy ignorance, it is true, since nobody expects the labourer or ordinary mechanic to be familiar with application of chemical laws—of men put in charge of automatic softening plants. But the fact that disturbing influences are liable to arise from so numerous and varied causes is sufficient to prove that water purification is not the simple undertaking it is generally supposed to be, and that it cannot be made a complete success automatically unless all the conditions are constantly favourable.

When treating with quick lime, either alone or in conjunction with soda ash, the chances of erratic results are much greater, principally because lime is habitually taken less care of than caustic soda. From the time it leaves the kiln it is exposed and at once starts to become hydrated by atmospheric moisture, or "air-slaked," and this process is immediately followed up by combination with carbonic acid gas from the air or any other source with which the lime comes in contact, till, given the right conditions as to time and environment, the whole of the quick lime, or calcium oxide, is resolved back again into chalk, or calcium carbonate, which is useless for water softening. It is highly improbable that the whole, or even half, of a quantity of lime would have become chalk before delivery and use at a water-softening plant; but to whatever extent the process of transformation has gone on, to that extent is the total percentage of calcium oxide reduced and the lime weakened. The cost of the deterioration in itself is inconsiderable. It is the trouble caused in the subsequent treatment of water with a reagent of uncertain and variable strength that becomes a matter of serious concern. In my experience lime supplied as 97.5 per cent. calcium oxide was on more than one occasion found to be 25 per cent. below that strength after it had been in stock two days, and kept during that time in a metal bin with a tight fitting lid. On the first occasion the man in charge of the softening plant, on finding that the water was cloudy when emerging from the settling chamber, concluded the prescribed quantity of lime used was not enough and went on adding more till the water was in reality largely over-treated, but still, to his perplexity, remained cloudy. This cloudiness was due to the finely divided chalk contained in the quick lime remaining in suspension after the iron oxide and reduced bicarbonate of lime and magnesia, formerly dissolved in the water, had settled down in the form of a flocculent precipitate. But when the theory of the deterioration of the lime was explained to him and a demonstration given that after half-an-hour's reburning in the boiler furnace the "spoiled" lime was efficient according to the prescribed weight, he was in a position to

cope with the trouble with the confidence of special knowledge, should it ever occur again. But it is not every man who has the opportunity of acquiring such special information when it is most needed. And therefore unless water-softening plants are under scientific supervision, either continuously or at frequent and regular periods, some inefficiency is unavoidable. In the nature of things it must be so when one considers the relentless precision of automatic action operating with other conditions that vary.

Pure soda ash (or partially refined carbonate of soda) may be obtained at a little under a penny per pound in quantity, of sufficient purity and regularity of strength to be quite reliable for the purpose of water treatment. But soda ash is applicable as a softener only to waters that are hard by reason of the sulphates and silicates they hold in solution. In this case the lime and magnesia give up to the soda the sulphuric and silicic acids with which they are combined, and take from it its carbonic acid, forming insoluble carbonates of lime and magnesia, which are precipitated, leaving in solution the harmless compounds of soda with sulphur and silica. But were soda ash added to a water hardened by the commoner causes, bicarbonates with free carbonic acid dissolved, no reaction would take place, and matters might be considered worse than before, owing to the addition of more unnecessary solids in solution. It can be used only in conjunction with lime, and then only in the purification of waters containing silicates or sulphates or both. Therefore, though it is less likely to prove a false friend than quick lime or caustic soda, its application is limited and it cannot be expected to take their place. The condition the most important in other chemical processes applies equally to water purification, and should be realised by all who own or have charge of such undertakings—that is, *care*, and a sufficient knowledge of what is taking place to render one capable of helping the apparatus to do its best work.

ORE QUARRYING IN THE BOUNDARY DISTRICT OF BRITISH COLUMBIA.

By E. Jacobs.

The interest of Mr. Jacobs' article lies not only in its description of novel mining methods, adapted to unusual conditions, but in its suggestion of a wide field for the profitable employment of mining talent and mining machinery. The position of the district makes it of international importance.—THE EDITORS.

ONE of the most striking features of mining in the Boundary District of British Columbia is the method adopted in dealing with the immense bodies of copper ore occurring in several parts of the district. The ore output of copper is now a leading factor in the production in Canada, the Boundary having last year produced 14,955,582 pounds of copper out of a total for British Columbia of 29,636,057 pounds, and for the whole Dominion of 39,154,733 pounds.

The Boundary comprises the south-eastern portion of what is officially known as the Yale District of British Columbia. It extends, approximately, from the summit of the divide between the Columbia River and Christina Lake, on the east, to that between the Okanagan and Kettle River valleys, on the west, and includes the greater part of the Kettle River (now Greenwood) and Grand Forks mining divisions. It is generally mountainous, though few of its mountains exceed 5,000 feet in height, and is intersected by four principal longitudinal valleys—those of Christina Lake, North Fork of Kettle River, Boundary Creek, and the main Kettle River, respectively. East and west its width is from 50 to 60 miles, whilst it covers 40 to 50 miles of country north from the international boundary line between British Columbia and the adjoining State of Washington.

It is about eighteen years since pioneer prospectors first staked copper claims in the district, only to abandon them afterwards owing to their inaccessiblity for practical purposes, and the unlikelihood that waggon roads or railways would be constructed so as to afford transportation facilities within a reasonable time. Later—in 1891—the Mother Lode, Old Ironsides, and Knob Hill claims, among many others, were located, but even then there was not a waggon road within miles of what have since been developed into the largest copper mines in Canada. By the summer of 1896, however, some little ad-

vance had been made in the direction of obtaining road communication, and in the autumn of that year a New York syndicate commenced to open up the Mother Lode, now a big mine owned by the British Columbia Copper Company, Ltd., of New York. The following autumn mining was begun on the Old Ironsides and Knob Hill, now part of a group of ten adjoining claims the property of the Granby Consolidated Mining, Smelting, & Power Company, Ltd., and thenceforward development work was steadily prosecuted. By the close of 1899 the Canadian Pacific Railway Company had built the Columbia & Western Railway into the district from the Columbia River, and this gave railway connection with the outer world. In August of 1900 the Granby Company's smelter at Grand Forks, B. C., commenced operations, and in February of 1901 the B. C. Copper Co. started smelting at its works at Greenwood. June of 1902 saw a third district smelter at work, this one being owned by the Montreal & Boston Copper Company, Ltd., and situate at Boundary Falls, near Greenwood. Up to the end of June of the current year these three smelters had together treated 1,164,621 tons of ore, in the following proportions: Granby Co. 769,485 tons, B. C. Copper Co. 326,223 tons, and Montreal & Boston Copper Co. 68,913 tons. Recent enlargements of all these works have so increased their treatment-capacity that by the close of this year the aggregate tonnage of ore treated will probably have exceeded 1,500,000 tons.

But it is not aggregate tonnage that has attracted wide-spread and interested attention to the district, for as yet this is small in comparison with the output of the older copper-mining districts of the United States. Rather is it the enormous size of some of the ore bodies, the low cost of mining practicable by open-cut or quarrying methods, and the favourable nature of the ores to rapid and economical smelting, which characteristics are remarkable to such a degree as to arouse incredulity among many not familiar with the unusual conditions prevailing here. The approximate dimensions of the respective ore bodies are stated in the descriptions that follow of the several mines at which quarrying methods have been adopted. With such large deposits of ore to work by these economical means, it will be readily understood that the cost of production in adequately equipped mines is kept very low. The cost of quarrying, inclusive of crushing the ore, and all office and administration expenses, is between 85 and 95 cents per ton. Of this crushing costs about 5 cents and administration expense about 10 cents per ton. Under favourable conditions even this low cost can be reduced. Further, the occurrence in the

larger mines of immense bodies of ore of varying character—silicious, calcareous, and ferruginous—fairly uniform in value and generally free from bismuth, arsenic, antimony, and other constituents objectionable from a smelting standpoint—makes it practicable to smelt quickly and without the use of barren fluxing material, and to produce directly a 45 to 50 per cent copper matte at a much lower treatment cost than is usual elsewhere.

During the field-work seasons of the three years 1900-1902 the Boundary District had the particular attention of a Canadian Geological Survey party, so that much valuable information relative to its topography and geology has been obtained and placed on record. Mr. R. W. Brock, geologist in charge of that party, describes the geological structure of the district as complex and diversified.

> "Eruptive rocks (including granites, greenstones, lavas and associated tuffs, and various intrusive dykes,) have the widest distribution. More or less altered sedimentary rocks (limestones, argillites, and quartzites,) together with more highly altered metamorphosed rocks, including serpentine, are met with in all parts of the district, but do not, as a rule, have large dimensions in any one place, being usually nothing more than inclusions of older formations, caught up in the intrusive rocks. The oldest rocks recognised in the district are the sedimentary and crystalline rocks."

Regarding the mineralogy of the district Mr. Brock remarks in part:

> "The ore bodies may for convenience be roughly divided into three classes: (1) The large low-grade copper-bearing sulphide deposits; (2) the oxidised copper veins, and (3) the small gold and silver-bearing quartz veins. Undoubtedly the most striking characteristic of the deposits of the first class is their enormous size. In structure these deposits belong to the composite-vein type, formed by mineralising solutions traversing the country rock, principally along fissures or zones of fissures in which they deposit the economic minerals, and from which they replace with their mineral contents, particle by particle, sometimes only partially and sometimes completely, the original material of the country rock. On the outskirts of the ore body this substitution may be seen in all stages of development, the individual constituents of the country rock being one by one replaced. According to the most prominent mineral content, this class of deposits may be sub-divided into a pyritic type, in which pyrrhotite and chalcopyrite, with some pyrite, are the chief minerals. Excepting that the pyrrhotite of the one is represented by the magnetite in the other, these two types appear to be identical. Both replace the constituents of the country rock in the same way; both are accompanied by the same accessory and gangue minerals, and the country rock shows the same alteration in both cases. Rarely do both pyrrhotite and magnetite occur in the same deposit. The values in the ores are principally in copper and gold, sometimes with accessory silver.

Further study is required to formulate the laws governing the distribution of gold values. Generally magnetite and pyrrhotite, when occurring alone, are almost barren, yet this is not always the case. Away from the chief centres of mineralisation, while magnetite and pyrrhotite are still sometimes found, the copper and gold are but sparingly present. A striking feature in the deposits is the general lack of surface oxidation or alteration. A few feet, at most, below the surface of the ground the ore exhibits the same character as in depth. The soil overlying the deposit is often quite unstained, affording no indication of the underlying ore, and consequently adding to the difficulties of prospecting. Sometimes the surface of the ore even retains the glacial polishing. The explanation of this feature is probably to be found in the heavy glaciation to which this region has been subjected. In one part of the district, however, oxidised copper-bearing veins occur, forming, at first sight, a totally different type of deposit. This type is probably an oxidised and secondarily enriched form of a sulphide deposit similar to the first-mentioned type of Boundary deposits, and produced by the action of surface waters. The iron of the sulphides has been removed or re-deposited as hematite or limonite; the copper has been more or less concentrated in the form of various oxidised minerals. At greater depth the unaltered iron and copper sulphides will, presumably, be found, although between the oxidised minerals and the unaltered sulphides it is quite possible a zone of enriched sulphides will be found."

From Mr. Brock's summary of some of the practical deductions from the study of the ore deposits the following is quoted:—

"Since, with the exception of certain deposits in Copper Camp, there is no zone of oxidation and secondary enrichment in these deposits, no loss of values is to be expected in depth, while the present general conditions remain unchanged. On account of the irregular form of the ore bodies and the complex nature of the rock formation, a careful and detailed geological study of the ground in the neighbourhood of the mine would be of great practical value in the exploitation of the ore bodies. For the same reason development work must always be kept well ahead of the actual mining. Cross cutting must frequently be done to determine the limits of the ore body and to prove the existence or non-existence of parallel ore shoots. What appears a barren wall may prove only a barren zone between two ore shoots. The limits of the mineralisation must be actually proved; and similarly only that ore can be reckoned on which has been actually blocked out."

Before giving information relative to individual mining properties in the Boundary on which ore is either being quarried on a comparatively large scale, or will be whenever transportation and treatment facilities shall be favourable to those not now producing ore, it may be premised that in a general way methods are similar wherever in the district this system of mining is in force. As a rule air-driven machine drills are used, 3¼ inch size, with a smaller drill for the deeper part where holes are deep, and, if it be desired to break down

a large quantity of rock, holes are "sprung" or "chambered," by first firing in the bottom of them a little explosive until a "chamber" has been made large enough to take sufficient powder or dynamite to do the work intended. The quantity of explosive used varies according to the conditions, the nature of ground, depth of holes, nearness to buildings liable to damage, etc., determining whether the charges shall be large or small. Where it is intended to break down large quantities of rock a round of holes will average 12 feet in depth, and the charge used will range up to half a case (50 sticks) of dynamite, or a proportionate quantity of black powder if that be used. Further blasting is necessary to break up the large rocks, but, unless these are very big, drilling is not required, the custom being to "bull-doze" them by placing high per cent. dynamite on the top of them and covering it with loose earth before firing.

The Granby Co.'s Mines.—The largest ore deposit yet discovered in the Boundary District is that occurring on the Granby Company's properties. The full dimensions of this are as yet unknown. Some time since the provincial mineralogist, after visiting the property, described this ore body as a "huge mineralised zone of fine-grained, eruptive rock, highly altered and occurring near a contact with limestone. Through this rock is disseminated yellow copper sulphides, magnetite, and magnetic iron pyrites, with small stringers of calcite, while, occasionally, the iron sulphides and oxides become massive." Dr. A. R. Ledoux, of New York, who visited the Boundary District about two years ago, was there informed that this ore contains on an average 38 per cent. of silica, 16 per cent. of oxide of iron, 15 per cent. of lime, and 4½ per cent. of sulphur, there being but little change between the surface and deeper ores so far as their chief constituents are concerned.

The earlier development done on the property consisted of the customary exploratory work by means of shaft-sinking on the Old Ironsides and Victoria claims and tunnelling on the Knob Hill, with cross cuts and drifts from these main workings. The No. 2 shaft, on the Victoria, was sunk to a depth of 400 feet and levels were run at 200 and 300 feet depth. It is a literal fact that on the former level two sections of ore, each fully an acre in area, were blocked out by having cross cuts or drifts so run as to show the ore on all sides of each block. One section of like area was similarly blocked out in the Knob Hill, on which claim a tunnel, known as No. 1, was started at the extreme northern boundary of the claim and driven diagonally across it a distance of 634 feet, until it reached the east side line, the

GRANBY MINES, PHOENIX, B. C.
Tramway Pits, Looking North to the Ore Crusher.

direction of which was then followed, the tunnel eventually entering the Grey Eagle claim. A vertical raise to the surface, started at 366 feet in from the mouth of the tunnel, was in solid ore its full height of 135 feet. Another connection between tunnel and surface was made at about 500 feet farther in. Cross cuts east and west from the main tunnel, started at the foot of the first raise, but which did not reach barren rock, proved the ore body to be there at least 200 feet in width at right angles to its general trend. Finding that the deposit of ore was of enormous dimensions, and that conditions were favourable to a more economical handling of it, ordinary methods of mining were departed from and ore quarrying here had its inception in the Boundary District. Eventually the raises were enlarged, more similar connections were made, and the ore was broken from the surface downwards, until latterly the top quarry, now known as No. 1 pit, assumed large proportions, being about 100 feet in width and having a face in ore about 300 feet in depth, including the raise from the level of No. 1 tunnel, and with the ore rising with the hill so that by the time the highest point of the outcrop shall be reached there will be a face of at least 350 feet. No. 2 pit is at a level between No. 1 pit and

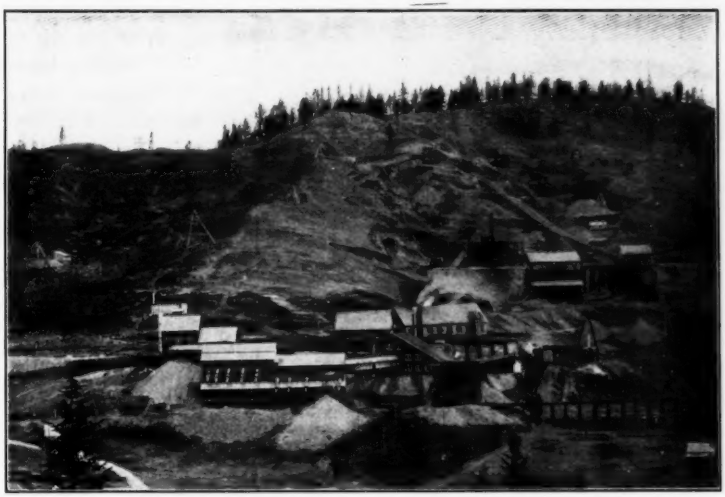
NO. 3 PIT, KNOB HILL MINE, WITH STEAM SHOVEL AT WORK.

No. 1 tunnel. No. 3 pit was started at the entrance to No. 1 tunnel and, of course, as it is advanced into the hill the entrance to the tunnel is carried back with the face of this open working. In this pit a steam shovel is used to load the ore, broken down by blasting, on tram cars which are hauled out and the ore dumped in a hopper above a big rock-crusher through which it is passed to the railway cars on the tracks below, for shipment thence to the smelter. The crusher, which is operated by a 100-horse-power electric motor, has jaws with an opening 42 by 30 inches, and it is designed to crush rock to a size of 7 to 8 inches at the rate of 150 tons per hour. Tunnels Nos. 2 and 3 have been started lower down the slope of the hill, on the Old Ironsides. Each gives 100 feet more depth, so that when No. 3 shall be under the highest point of the outcrop it will give a vertical depth of about 550 ft. But it is hardly probable an open quarry will be worked to that depth, owing to the risk to men working below from rocks becoming detached and falling from the faces or sides of the pits.

The greatest width of the ore body on the Knob Hill is stated to be about 400 feet, but the ore quarries have not yet been opened more than about a quarter of that width. This deposit is known to be continuous for at least 2,000 feet in length, from the Old Ironsides

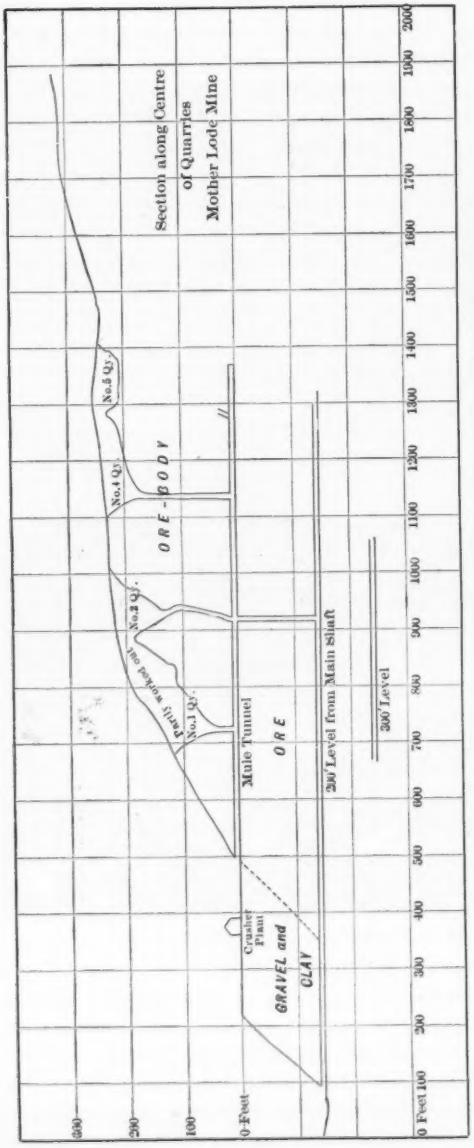
through the full length of the Knob Hill and thence into the Grey Eagle. It must be left to time and much more development work to show how much farther it extends, but since it has a known depth of at least 800 feet, where prospected in the Victoria by means of a diamond drill, there is assuredly an enormous mass of ore from which to mine and ship a large tonnage for many years. The output of ore whilst four furnaces are in blast at the company's smelter is from 1,200 to 1,400 tons per day, and, with the two additional furnaces lately put in also running, the tonnage will be increased to about 2,000 tons daily. To mine and ship this latter quantity of ore between 350 and 400 men will be regularly employed in the Granby Co's mines.

The B. C. Copper Company's Mines.—The British Columbia Copper Company owns the Mother Lode group of six claims, which are situate three miles west of Greenwood, whilst the Granby Company's mines are at Phoenix, five miles to the eastward. The ore body on the



GENERAL VIEW OF THE GRANBY MINES, PHOENIX, B. C.

Mother Lode is similar in many respects to that above described, except that it has not yet been proved to be nearly so large. For several years development work was done underground, and much cross cutting and drifting at the 200 and 300-foot levels have proved that here, too, a large body of ore of a shipping grade is available. The lode is traceable by continuous outcroppings for some 1,100 feet north of the main shaft to where it disappears under heavy drift, whilst a



SECTION SHOWING METHOD OF WORKING, MOTHER LODE MINE, NEAR GREENWOOD, B. C.

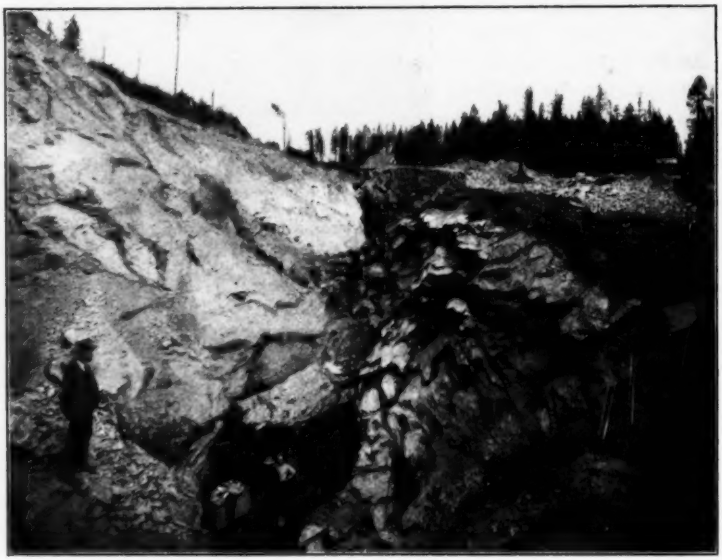
surface exposure about 700 feet from the shaft in an opposite direction suggests the probability of its extending at least that distance southward under the intervening drift. Its surface width varies from 80 to 160 feet. A main tunnel has been driven 850 feet into the hill on a level with a bench on which have been erected ore bins and other facilities for ore shipping. From this tunnel several exploratory cross cuts have been run to determine the width of the ore, and three big raises have been made to the quarries above. The main quarry was opened at a level about 110 feet above that of the tunnel, and other quarries below and above. From the highest point at which the ore outcrops on the hill down to the level of the main

tunnel the depth is about 260 feet, and down to the bottom of the main shaft, which is also in ore, about 530 feet. Half a dozen quarries have been opened at different places, those on the top of the hill giving a larger percentage of sulphur, which facilitates matte making in the smelter furnaces. The raises from the tunnel to the quarries are funnel-shaped at the top, so that when blasted down from the faces of the quarries, the ore may fall into them without handling. Rocks too large to pass through the bin gates of the hoppers at the bottom of the chutes are "bull-dozed." The ore is drawn from the chutes into 3-ton cars, which are hauled by mules to a rock crusher having a capacity of 65 to 80 tons of rock per hour crushed to a size not exceeding 5 inches. From the crusher pit an elevating machine raises the ore to shipping bins above the railway track. The Mother Lode is opened up sufficiently to enable it to maintain an output up to 1,000 tons per diem, whenever the company shall increase the treatment capacity of its smelter to require that quantity in addition to custom ores it also treats.

NO. 1 AND 2 QUARRIES OF THE MOTHER LODE MINE, SEEN FROM ABOVE.

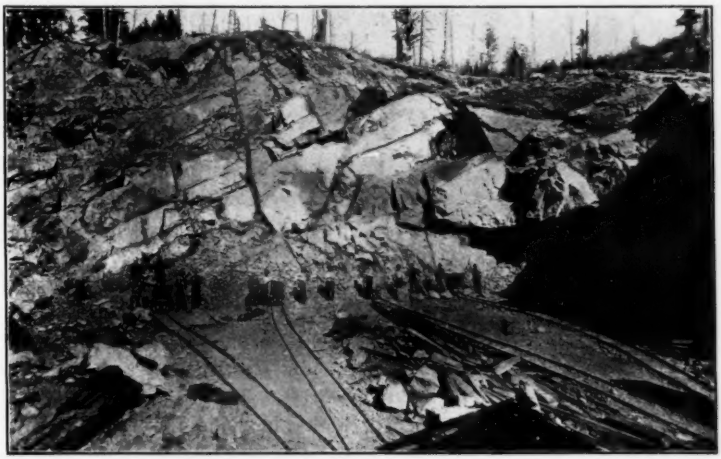
Snowshoe Gold & Copper Mines, Ltd.—The Snowshoe group is situate near Phoenix. Here, too, quarries have been opened in big bodies of ore, the full extent of which will not be known until after much more exploratory work shall have been done. Tunnels have been run in at two levels, raises made to open workings above, and

THE SNOWSHOE MINE QUARRY, SHOWING MOUTHS OF THE RAISES.



SNOWSHOE MINE. QUARRY BROKEN THROUGH TO THE UPPER TUNNEL.

the ore broken down in the same way as on the mines above described. The main three-compartment shaft is down 347 feet. At 140 feet it passes through the main tunnel, known as No. 1 level, from which all ore mined above that level is trammed to bins above No. 2 shipping track. Ore from No. 2 and No. 3 levels is hoisted in 2-ton skips, run in balance, and trammed to other bins, over No. 1 shipping track, which also receive the ore broken down in open workings above the upper tunnel. The mine is already in shape to ship 500 to 700 tons



THE FACE OF NO. 1 QUARRY, MOTHER LODE MINE, NELSON, B. C.

of ore a day, and as more room shall be made and more ore faces opened it will be practicable to increase the output steadily.

Montreal & Boston Copper Company's Mines.—This company owns the Sunset group, adjoining the Mother Lode. The main shaft on the Sunset is down 400 feet, and several levels have been run between the surface and that depth. Above the 100-foot level a cross cut tunnel was driven through a big knoll of copper-stained rock which it is estimated contains at least 250,000 tons of ore. Raises from the 100-foot level to open workings in this big body of ore admit of the ore being broken down into chutes from which it is trammed to the shaft and hoisted thence to the shipping bins. The Montreal & Boston Copper Co. has its own smelter, with three furnaces, at Boundary Falls, whence Sunset ore is shipped to supplement custom ores.

Oro Denoro and Emma.—These mines are situate in Summit camp, near Eholt and about a dozen miles distant from Greenwood.

THE EMMA MINE WORKINGS, EHOLT, B. C.
Hall Mining & Smelting Co.

The Oro Denoro is operated by the Denoro Mines, Ltd., and the Emma by the Hall Mining & Smelting Co., Ltd., of Nelson, B. C. The Emma commenced shipping last year from a large deposit of ore, into which an open cut has been made about 50 feet in depth and 25 to 30 feet in width. Other openings have lately been made, and these show that here, too, ore occurs in such quantity as to give promise of a considerable output being continuously maintained. Ore quarrying on the Oro Denoro is of more recent date than on any other property in the Boundary, operations having only been commenced last June. Two quarries have been opened, both alongside the railway line. When visited early in August the removal of surface drift had exposed an ore body 69 feet wide, so far as uncovered, and dipping under the wash on both sides. A face of ore 30 feet in depth had been opened, and the steepness of the rise was giving additional depth as the quarry advanced into the hill. The second quarry was lower down the railroad and about 100 yards distant.

King Solomon and Copper Mine.—These are the only two properties as yet opened in the district in any considerable body of oxidised copper and iron ore. On the King Solomon an open cut was run into the hill and about 1,000 tons of ore, running much higher in copper than the general average of Boundary ores, were taken out. Similarly on the neighbouring Copper Mine claim masses of oxidised ore occur near the surface, as exposed in open-cut workings run for 93 feet in an ore body, the surface dimensions of which are about 174 feet by 84 feet. Lack of suitable transportation facilities is a present obstacle in the way of these properties shipping ore, the nearest railroad point being about five miles away.

That more big deposits of ore will yet be discovered in the Boundary may be taken for granted, for the district has not yet been extensively prospected and surface indications of the presence of mineral are frequently absent. Even the few now being opened up on an extensive scale have attracted much attention and their size and commercial value have occasioned surprise. The district has enormous possibilities, and it may be worth the attention of manufacturers of mining and smelting machinery and plant desirous of enlarging their business connections. Although it is only three years since smelting operations, with a single blast furnace, were commenced in the district, there are now three local smelting works having an aggregate of eleven water-jacket furnaces, and these are not nearly equal to the present ore-producing capacity of the mines now operating, so that considerable additions are even now required, and these will be made immediately a regular and adequate coke supply is assured. Space limitations prevent many details being given of plant and machinery already installed in the district, but it may be briefly stated that the Granby Co. has at its smelting works six blast furnaces, one tilting furnace, two stands of copper converters, seven blowers, two travelling cranes, plant for generating electric power, electric motors, two complete sampling plants with large rock crushers, briquette-making machine, and much more plant, whilst at its mines are two compound air compressors together rated at sixty 3¼-inch drills, two 700-horse-power electric motors to operate them, a big ore crusher with 100-horse-power motor, full steam equipment with air compressors, hoists, etc., timber framer with all appliances, machine shop equipped with modern power machines and tools, etc. The B. C. Copper Co. has two blast furnaces at work, two blowers, steam and electric-light engines, sampling mill plant, etc., and is arranging for making additions, and at its mine a forty-drill compound air compressor, large double-drum winding engine, rock crusher, elevating machine, etc. The Montreal & Boston Copper Co. has at its smelting works three blast furnaces, three blowers with direct-connected engines, sampling mill, and all the usual smelter equipment. All three smelters have ordered locomotives and slag trucks, for dumping slag hot. The Snowshoe mine has installed the high-pressure half of a thirty-drill air compressor, 150-horse-power double conical drum electric hoist, and other plant, whilst a dozen other mines in the district have steam power plants, and the Cascade Water Power & Light Co. has put in turbines, generators, transformers, and other equipment necessary for generating 2,000 horse-power, with the intention of later increasing to 6,000 horse-power.

THE ETHICS OF WORKSHOP MANAGEMENT.

By Egbert P. Watson.

Mr. Watson's writings on industrial subjects are always interesting and instructive, because they are expressions of the things he has seen and lived. He is emphatically an "insider" in shop affairs. Others of equal experience may hold differing views on important points; it is indeed probable that many managers would look to the melioration of trades-union aims and conduct, rather than to the decline of trades unionism, for hope of relief from the present ills of organised-labour origin. But Mr. Watson knows the American mechanic intimately and individually, and is on long familiar ground when he deals with the practical running of the shop.—THE EDITORS.

A CONCERN that employed a very large number of men upon machine work some years ago discovered that they were not making any money, and as one step toward a remedy had decided to cut down wages. The nominal superintendent of the works was a Scotchman with very old-fashioned ideas as to shop methods and management of men, and one of the firm got an idea that he was the source of the discrepancy between outgo and income. He knew that it would be useless to undertake an investigation in person as to what went on in the shop during working hours, or the absence of the superintendent in other departments, for the reason that his presence anywhere in the vicinity would be discovered at once, and phenomenal activity in all departments ensue as a natural result; so he conceived the idea of putting on an assistant superintendent and seeing how that would work. He called the superintendent into the office and broached the project without any hint as to the reasons for the action, and asked him to name a suitable man for the place. He was of opinion that there was not any one in the shop capable of it, and suggested advertising for a man. This was not done, the firm having another plan in view, which was, in brief, to try one of the men in the shop first before taking any other steps. Curiously enough, the one selected was about the last any one unacquainted with his peculiarities would have chosen, being, as he was, a short-spoken, quick-acting workman with no external evidence of executive capacity. He was called into the office and asked if he would like to have the job; at first he demurred, but when it was explained to him that if he did not accept it would be offered to some one else, outside of the shop, he consented to try it and asked for instructions as to what was expected of him.

He was told that in future the general superintendent would confine himself to certain departments, and that the assistant would have other branches under his own special jurisdiction. No one but the firm would have control over him, or issue any orders, and he would be judged solely by results. It was clearly explained to him that the quantity of work turned out by the shops he had, or was to have, charge of did not come up to the mark, and since it seemed that the general superintendent had reached his limit, or had, possibly, too much to look after, it had been decided to appoint an assistant. The workman was then asked what he would need in the way of an office or locality to keep his records and blue prints in, and having given his views he departed to continue his work in the shop. No announcement of the addition to the officers of the shop was made by the firm for the moment, they being desirous of discovering if it would leak out through the workman himself, but after a week's delay, finding that the change was not common gossip, they came to the conclusion that, so far, the workman had shown that they had made a good choice.

A notice was then posted on the bulletin board that on and after a certain date John Doe would act as assistant superintendent in shops A, B, and C, and he was left to his devices. The firm thought that the new man might develop the weakness of favoring some of the men to the disadvantage of others, but nothing of the sort occurred; it appeared that he had "no friends to reward or enemies to punish," and that in all respects he justified the wisdom which prompted his choice. It transpired also that he had no pet theories, or systems of management, but simply went ahead to get the work out at the lowest cost and with the least delay—none at all in fact, because he took care to see that the machine tools were never idle except when they were stopped to take out, or put in, jobs, and as for the men themselves he took no notice of them whatever. That is to say, he did not fuss around them, harassing them by his presence, or intimate by word or deed that they needed watching. Some of them were shirkers, but after a brief experience of the new *régime* they disappeared and their places were taken by men who were willing to give a fair day's work for a fair day's pay.

The firm, when they appointed this workman as assistant over his fellows, felt that, possibly, there might be jealousy engendered which would militate against his usefulness, but this did not happen, for the men seemed to be glad that one from among them was chosen instead of an outsider and co-operated with him harmoniously in every detail. They said he was "a square man," and that it was a good shop to work in, which is the highest grade of certificate that can be given. When

the new assistant came into power there were framed rules of conduct hanging on the walls of every department; men must do this and must not do that, under divers pains and penalties for disobedience, but by some mysterious agency they disappeared, and nothing whatever happened. The new man argued, possibly, that men cannot be made neat, orderly, punctual, and honest by codes, and therefore the latter were superfluous. For other measures tending toward improvement he had all blue prints to be worked from in his department delivered to him some weeks before they had to be put in hand, so that he could revise them and make requisition for bills of materials needed and have them going forward from other departments to his, in order that he would not have to wait for them when he was ready to do the job. So many shafts so long, such a number of machine castings as per pattern "C," bolts and nuts as specified—in a word, all the material for any given job under his hand. If he found any discrepancies in the blueprint details (sometimes he did) he would go to the drawing room and ask the draughtsmen personally who made them, if there was not an oversight, and point out the place. This kept good feeling toward him everywhere in the works, and all were willing to swear by him.

The man who has been described in previous lines is not a fictitious person to "adorn a moral and point a tale," but one who lived, moved, and had his being in New York City. He was a man from the ranks, and simply did his duty as he understood it and as he would be done by. He had no sinecure, either; it was not a little seven-by-nine shop, but a concern that employed 3,500 men when in full work, but he was equal to any number of men, in so far as his capacity was concerned, because he had executive talent and understood the men under him and what they had to do. He went further than the routine of shaper, planer, and lathe with them and was personally interested in all that concerned their lives and their families; without being intrusive he could sympathize with their troubles and trials, and very often helped them by advice and counsel. His advancement to a responsible position in the works was a distinct gain to them, and I wish I could add that, in due time, he was told to go up higher still; but it was not to be, for after a few years he passed on, higher than any position this world can give, and is remembered to this day by those who survive him.

Is it too much to assert that managers, like poets, are born, not made? It seems to me that it is true. I have seen plenty of so-called managers, persons in such positions, who hedged themselves about with the dignity that "doth become a king," and seemed to think that workmen belonged to the lower classes, so called, and would no more

think of addressing them civilly than they would of consorting with them. These are the kind of managers who issue pronunciamentos, and rule by force, forgetting that the men can retaliate an hundred fold for every indignity put upon them. Where such officers are in power there is always dissatisfaction and misrule, because men will not do their best under such a condition of affairs, and good men will not put up with ill treatment for any amount of wages.

In a long and active life among workmen of all sorts of trades I have never found them unreasonable or exacting in any respect. There have been exceptions, of course, but these only prove the rule that if you do as you would be done by there will be less friction for all concerned. Owing to environment and the law of heredity—if there is such a law—there are, unfortunately, some natures which no amount of kind treatment can anneal or render tractable for the business of life. They do not comprehend the intentions of those who would befriend them and help them on their way; they are cursed from their mother's womb with the spirit of fractiousness and irritability, and make shops veritable hells if they are retained in them. I have had a few instances of this kind in the course of time, but I have never felt that it was right that many should suffer for the faults of one or two, and have had no compunction in dismissing them out of hand. I have had a gang of newly arrived Italians to deal with as handy men on drilling and laboring work about the shop, and if there is any class lower in the scale of humanity than they are I never met them. They are as strong as mules, and much slower so far as learning routine is concerned, for a mule can remember some thing; it seemed as if these men never would. They understood no word of English, but all directions as to what they should do had to be given by signs. Even these men knew when they were well treated, and divined the intention by some sort of intuition, as dogs do; after awhile, say a few months, they began to comprehend what was required of them, and it was almost pathetic to see the eagerness with which they tried to read the wishes of the foreman in charge. Low in the scale of intelligence as these men were, as we reckon that quality here, they knew when they were well treated and strove to show by their willingness that they appreciated it. Their attitude toward their employers serves to support my contention, as set forth in previous lines.

The older I grow the more confirmed I become in the view that the majority of American workmen do not need "management," so-called; they do not require to be watched in regard to their contract to render a fair equivalent for the money they receive. I have had some watch-

the-clock men as well as others, but they were few and far between—half a dozen out of an hundred and fifty men, possibly—but even their fellows held them in low esteem, and saluted them when they were manifestly dawdling with "take your hands out of the bosses pocket and go to work." In other words, they let the "sojers" understand that their shortcomings were detected and repudiated. I said a few lines back that the majority of American workmen do not need management, and this assertion stands, so far as my personal experience goes, and that is not an exceptional one. I have had to take on men as they came to hand, so to speak, because when help is urgently wanted the first man who comes in is the best fellow, if he is at all possible, and is set to work. It may be that I have better snap judgment than some, or, from long association with those who live by the labor of their hands, can "size them up" as the phrase goes, and distinguish good men from bad with but a small margin of error; but whatever the reason may be, the fact remains that I have been well served, and hold American workmen in the highest esteem as personal friends—when time has shown me their worth. Even the misguided minority who have listened to the charming of the serpent of trades unionism still have my regard, in the hope that they will turn from the error of their ways and forswear forever allegiance to the alleged leaders of the movement. The majority of American workmen repudiate these men, as is shown by the few who have embraced the false doctrines so zealously preached, and I earnestly hope and believe that the day is not far off when American workmen will resume their individuality and independence, redeeming the mortgage which demagogues now hold upon these qualities.

Workmen are cosmopolitans, hailing from here, there, and everywhere; much going to and fro over the earth has rubbed off the prejudices and notions acquired by sitting down in a small town and coming to feel that its low horizon comprises all that is to be learned; they give and take more readily, and easily distinguish and detect the fair and square manager from one who is working them for all they are worth. They are easily managed, or are unmanageable, according to the way in which they are treated.

EDITORIAL COMMENT

WHEN after months of anxious—almost desperate — care and economy in 1897 the country began at last to feel sure of the returning tide of prosperity, no expression was more common than that "we had learned lasting lessons in prudence and conservatism." Starvation, or at least a very low diet, we were accustomed to say, had sobered us from our preceding state of industrial intoxication, so thoroughly that the reform was to be permanent. Hereafter we would be more cautious, less easily carried away by over-enthusiasm, and our progress would be far steadier and hard times would recur no more.

And taking the statement as it was intended to be applied—to the manufactures and industries of the United States—it has been well borne out by the facts. Never before, probably, did we keep our poise so well under conditions of so great temptation. So far as the physical side of our industries is concerned, and especially our engineering industries, we have shown a deliberation in expansion, a soundness and sense of proportion in putting forth new growth, that in itself now assures the health of the body industrial and its ability to endure a much more severe strain even than it has suffered from the antics of the cloud builders of Wall Street. The dominant factor in bringing this condition about is the technician. Trace back the story of any great enterprise —manufacturing, mining, metallurgical, transportion—and the genius of its success will be found to be the clear-sighted ability of a trained engineer. The past decade has seen his province vastly extended, and so far as his province goes the work is almost all sound—built for periods of storm as well as for pleasant weather and sunshine.

But the devils which were cast out of our industrial leaders, with the prayer and fasting of the last hard times, straightway entered into the leaders of Wall Street. The trust madness seized upon us, sevenfold more violent than the railway craze of a quarter century ago. A new order of "financiers" sprang into being, whose mouths watered at sight of the goodly properties created by the wealth-making ability of the engineer. The promoter arose and garbed himself as the "Napoleon of Finance". He took the solid work of the practical man as a suggestion with which to hypnotize his following, and they wandered in dreamland, seeing in visions rosy and magnified and manifold. The spell is failing, and the sober awakening is somewhat cold and depressing; but the solid ground is there, little shaken by the fall of the cloud palaces Wall Street built and common sense has destroyed. A craze has passed; certain idols have crumbled upon their feet of clay and fallen; the small investor, who bought wind and water—God help him and her! But the country is sound, and prosperity not likely to be very seriously checked.

In view of the developments of the past month, we are tempted to quote in this connection a few sentences from an editorial in our issue of October, 1903—just thirteen months ago :

"The flippant term 'Napoleon of Finance' embodies a fundamental truth. The same restlessness of conscious power, the same hungering for empire, the same craving for the intoxication of victory, now find in the field of industry the outlet that once was to be found only in the field of battle. And the same glamor of immediate success dazzles the people and throngs them about the victor, delirious in the glory of the present, careless of the stability of the future. But the same law underlies all nature, and will not be denied. The overblown bubble will burst—the overstretched fabric will break—the unstable structure will fall. * * * The analogy is plain. The American leaders of finance, beginning with undertakings which had economic justification, but since drunken with success, have expanded their campaign to the limits of dreamland. * * * When the 'financier' leaves the engineer and the industrial manager out of his counsels, the end of his triumphant progress is in sight. When success in floating securities is put above success in mechanical invention, in works organization, in labor handling, and in cost reduction, the defeat of the 'American invasion' is close at hand.

"A like recklessness led to Napoleon's winter campaign in Russia. What will be the suffering, and what the proportion of loss, in the impending retreat of the American Napoleons of Finance?"

* * *

THE arrival of the Mosely educational commission in the United States calls attention to the earnestness with which the problem of technical education and its relation to industrial progress is being studied in Great Britain. The value of the reports of the preceding industrial commission has been shown by the extent to which various portions have been published and reviewed, and we have no doubt that the work of the present party will receive an equal welcome on both sides of the Atlantic.

Among the members of the educational commission will be found the names of many eminent educators, and the opportunities which are being given to them to study the relation of technical education to modern industry should be of material value in the present emergency with which Great Britain is confronted.

That there is an emergency must be admitted, and one need turn only to the recent addresses of Sir Norman Lockyer and of Professor Boys, before the British Association, to realize how the matter appears to men of science. In fact, it is widely assumed in England that technical education has something very definite to do with industrial progress, and Mr. Mosely has arranged the visit of the commission to the United States to find out, if possible, what this connection is.

Naturally there is a difference of opinion as to the effect of a technical training upon a man who is afterwards to take an active part in the industrial world. Many men appear to think that technical education is a good thing on general principles, and that if you only have plenty of it somehow a favorable effect will be had upon general industry. Others insist that manual training is the thing, and that the schools must be a kind of cross between the college and the workshop, producing a sort of scientific workman ready for anything. As a matter of fact, various methods are applicable for various conditions, and no general rules can be laid down as to what shall constitute the one superlatively best system.

* * *

APART from the methods of education, which must, in great measure, be determined by questions of environment, the important matter is that the tech-

nically trained man shall be given opportunity to use what he has acquired, and become an active productive member of the community. As Dr. Louis Duncan says, elsewhere in this issue: "In the industrial battle being fought between nations, the most important weapon is an intelligent man technically educated."

Comparing technical education with military matters still further, what would be thought of a government which, after maintaining at great cost schools for imparting a thorough military education to thousands of young men, should take no interest whatever thereafter in placing them in suitable posts where the benefits of their training could be secured? When men have been educated for the art of war they are promptly placed where they shall give some return to the government by which they have been educated, and there is no manner of doubt as to the value and effectiveness of the trained soldier over the uneducated recruit, no matter how enthusiastic and earnest the latter may be.

Here then is the crucial point in the connection between giving the education and reaping the benefit. It is not enough to provide ample facilities for an army of young men to obtain the best sort of a technical training; there must be added to it such a connection between the school and the manufactory that the transfer from the one to the other shall be direct and continuous; the men must not only be trained, they must also be used. To give a man a special education, and then to turn him adrift to find lodgement where he may, is a line of conduct which, if practised in military affairs, would instantly meet with loud and well merited denunciations, and yet who can say that this is not too often the method, or lack of method, existing in many places, in connection with technical training?

It is not to be expected that the technical school shall of itself form the connection between the giving of the education and the application of the results. The military academy does not place the men in the army; that is already provided for elsewhere. It is to the employers, to directors of great enterprises, to men who use men, and who know how to use them, that the appreciation of the technically trained graduate must be taught. Many leaders of industry know already the importance of securing the services of technically trained men, and in the United States especially, are the graduating classes of the technical schools in continual demand for immediate service in the workshop, the factory, and the mill. This phase of the question will be fully treated from concrete examples in the succeeding issue of the Magazine, but we may emphasize here that this is the great difference between technical training in England and in the United States. We feel warranted in saying that the members of the Mosely commission will not find what they seek in the class rooms of American colleges and schools, nor yet even in the mechanical laboratories and departments of original research. England possesses many technical schools of high standing, but who can say that the British manufacturer stands anxiously waiting to secure the graduates to give them positions at living wage, without premium, desiring only to reap the benefit of the latest information, and freshest methods in the prosecution of his work? True, there are some far-seeing men in England, who appreciate the value of what others have been throwing away, and we have already spoken in these columns of the good work initiated by Mr. Yarrow in advocating the abolition of premiums and urging the payment for services of student apprentices, but the work has but been

commenced, and by far the greater number of British employers still hold to the older methods.

If the Mosely commission will study the connection between the school and the shop, if they will visit the great manufacturing establishments which have been foremost in pushing the products of American industry to all parts of the world, they may there find the secret of the relation of technical education to industrial progress, for they will see shops filled with men from the technical schools, they will discover how the latest scientific methods and appliances are produced and intelligently used to forward American industry. England has educators who are the peers of any in the world, and it is men rather than methods that make the true eminence of educational institutions. What she lacks is not improved methods of teaching, but intelligent appreciation of the right use of the men she is already training. Not all of the twenty-four millions for which Sir Norman Lockyer asked will avail her if she persistently fails to use the products of the technical schools for which he pleads so powerfully. It is her employers who need awakening; her educators are wide awake already, but their work is but half the task.

* * *

It is not always easy to regulate things beyond our power, and in the semi-official reports which have been made public concerning the work of the wireless-telegraph congress we are strongly reminded of the conference of the mice when they decided that it would be well to put a bell upon the cat.

Having found that telegraphic messages can be sent through space without official permission, and even without the source being directly discoverable, the officials of various governments promptly assumed that they could control these performances, and solemnly assembled in congress to take possession of the ether and issue rules for the regulation thereof.

With such limited information as is available concerning the work of this assembly, it appears that they soon discovered that the ability to enforce their enactments was limited to terminal stations on their own territory, and that even in such instances the power of control was not absolute. Two resolutions, however, were adopted, the first of these ruling that all coast stations shall be obliged to receive and transmit all telegrams for ships at sea without regard to system, and shall give precedence to appeals for help, and also regulating the tariff for the land portion of the transmission; and the other asking the various operators to be good, and not interfere with each other any more than absolutely necessary.

* * *

As long ago as 1831, when Darwin made his famous "voyage of a naturalist" in the Beagle, the longitude of the various islands in the Pacific was determined by the comparison of local with Greenwich time, the ship carrying a large number of chronometers in order to insure especial accuracy for this, the main object of her cruise. Now, however, this determination has been made with a far greater degree of accuracy, by reason of the completion of the Pacific cable. By comparing the telegraphed time from points of known position, such as Vancouver on the Pacific coast and Brisbane in Australia, the relation of these ports to each other and to the intermediate points on Fanning island and on the Fiji islands have now been positively determined, and thus the girdling of the globe is completed.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE INFLUENCE OF SCIENCE UPON INDUSTRY.

THE INFLUENCE OF BRAIN POWER UPON HISTORY—ORGANISED SCIENCE AND NATIONAL COMMERCIAL SUPREMACY.

Sir Norman Lockyer—British Association.

IT has become the fashion of late to poke fun at the British Association for the Advancement of Science, and to seize upon the addresses and discussions as suitable material for alleged humorous comment. This tendency appears in most of the comments upon the addresses at the recent meeting at Southport, notwithstanding the fact that the speakers were among the notable men of science of the United Kingdom; holding offices which have been filled by such leaders of thought and work as Tyndall, Huxley, Kelvin, and Stokes. It is easy for the newspaper paragrapher to take such an address as that of Sir Norman Lockyer as material upon which to fling his clumsy wit, but certainly Sir Norman can stand it with serenity and silence, while those who care to think and study his words may well forget the attacks and devote themselves to doing their share in aiding the progress of the cause which has been so well advocated.

Once upon a time history consisted almost altogether in accounts of the battles and campaigns of the soldiers of the nation whose story formed the subject of the narration; the brutal stage was still on, and fighting was the only thing worthy of record. By and by a great discovery was made, and it was found that the real life of the people was entitled to some share in the history of a people, and great was the applause which fell to the fortunate writers who exploited the new school of annals. Even these, however, failed in great measure to realize that the accounts of local political campaigns, of religious squabbles, and of agricultural and commercial relations formed but a portion of the true history of a nation, and both soldiers and politicians are most reluctant to admit that the power which they have fondly fancied to be entirely their own must be shared with the men who really do the things which change the face of the earth and the conduct of affairs, with the engineers, the scientists, the professors, and the students of their own and of all other nations. It is this side of history, and it is this kind of brain power of which Sir Norman Lockyer speaks, and his words may not well be ignored.

Thus, in introducing his subject, he says:

"I think, although it is not generally recognised, that the century into which we have now well entered may be more momentous than any which has preceded it, and that the present history of the world is being so largely moulded by the influence of brain-power, which in these modern days has to do with natural as well as human forces and laws, that statesmen and politicians will have in the future to pay more regard to education and science, as empire-builders and empire-guarders, than they have paid in the past.

"The nineteenth century will ever be known as the one in which the influences of science were first fully realised in civilised communities; the scientific progress was so gigantic that it seems rash to predict that any of its successors can be more important in the life of any nation."

It does not yet seem to be fully realised by those to whom the conduct of affairs in Great Britain has been intrusted how great a part in her past power has been played by the forces and methods which they so easily ignore, and while they perceive and deplore the decline of national industries from which a great portion of the national wealth has been drawn, they are unwilling to admit that a large portion of that decline has been due to the neglect of scientific education and scientific methods of work and thought.

There is little doubt that by the middle of the nineteenth century Great Britain was far in advance of the rest of the civilised world, and that this pre-eminent position was due both to the magnitude of her natural resources and to the extent to which she had availed herself of the development of scientific methods of work. The application of science, and the development of engineering gave her command of her own resources and control of the sea, a combination which made her the richest country in the world, "the seat and throne of invention and manufacture."

But, as Sir Norman Lockyer points out, there is nothing so cosmopolitan, so international, as the development of science, as although Great Britain had a long start of the rest of the world in the practical applications of scientific methods, she could not expect to retain that lead without continual and strenuous effort. The resources upon which England has had to depend may be divided into two classes, her material resources and her mental resources. The former have naturally been subject to decline, being under a continual drain of accelerating proportions, while the latter, the portion wholly under human control, has been greatly neglected.

Says Sir Norman Lockyer:

"So little did the bulk of our statesmen know of the part science was playing in the modern world and of the real basis of the nation's activities, that they imagined political and fiscal problems to be the only matters of importance. Nor, indeed, are we very much better off to-day. In the important discussions recently raised by Mr. Chamberlain, next to nothing has been said of the effect of the progress of science on prices. The whole course of the modern world is attributed to the presence or absence of taxes on certain commodities in certain countries. The fact that the great fall in the price of food-stuffs in England did not come till some thirty or forty years after the removal of the corn duty between 1847 and 1849 gives them no pause; for them new inventions, railways and steamships are negligible quantities; the vast increase in the world's wealth in free trade and protected countries alike comes merely according to them in response to some *political* shibboleth.

"We now know, from what has occurred in other States, that if our Ministers had been more wise and our universities more numerous and efficient, our *mental resources* would have been developed by improvements in educational method, by the introduction of science into schools, and, more important than all the rest, by the teaching of science by experiment, observation and research, and not from books. It is because this was not done that we have fallen behind other nations in properly applying science to industry, so that our applications of science to industry are relatively less important than they were. But this is by no means all; we have lacked the strengthening of the national life produced by fostering the scientific spirit among all classes, and along all lines of the nation's activity; many of the responsible authorities know little and care less about science; we have not learned that it is the duty of the State to organise its forces as carefully for peace as for war; that universities and other teaching centres are as important as battleships or big battalions; are, in fact, essential parts of a modern State's machinery, and as such to be equally aided and as efficiently organised to secure its future well being."

Assuming, then, that it is the duty of the State to foster its mental, as well as its military strength, Sir Norman Lockyer does not mince matters, but boldly demands as much money for the establishment of universities and technical schools as is expended upon the maintenance of the navy. There is no manner of doubt that if the sea power of the kingdom is not kept up, and even increased as the power of other nations is developed, the safety of the nation cannot be assured. In like manner, it may

well be maintained, if the brain power of the nation is neglected, the material and commercial power of the country must decline. It has been said that England has to regard the increasing armaments of other nations as a menace, while the advances made by all the rest of the world in science become hers as well, there being universal free trade in ideas, although not as yet in commodities. To wait calmly, however, and permit the rest of the world to make the technical progress and at the same time develop natural resources, in the hope of being able later on to gather what has been made public, is hardly the position for a nation to assume which has so long been accustomed to lead; a policy of "muddling along somehow" will not appeal to thinking scientific and commercial men at this late date.

The power of education and technical training to strengthen the position of a nation is well seen in the instances of Prussia after Jena and of France after Sedan, and to the development of education in both countries their tremendous increase in national power must be attributed. Japan, also, may be cited as a nation which has raised herself to the peer of the modern powers of Europe in less than a generation by appreciating the power of scientific training in strengthening a nation.

Space is here lacking to discuss this great subject in detail, but enough has been said to draw attention to the plans laid before the British Association by its President. That the time must come when the influence of national science upon national strength is realised, we fully believe, and the advent of that time may well be hastened by such appeals as that which has been made by Sir Norman Lockyer.

THE GRAND CENTRAL RAILWAY OF EUROPE.

A PROPOSITION FOR A NEW INTERNATIONAL RAILWAY SYSTEM FOR CENTRAL EUROPE THROUGH FRANCE TO THE SEA.

Louis Lafitte—Le Génie Civil.

WITH the approaching completion of the Simplon tunnel and the consequent outlet which it will give to the route of the Simplon-Jura railway into Italy, the effect upon the railway systems of central Europe becomes a matter for consideration. Especially will this fresh opening through the barrier of the Alps affect the railway business of France, adding as it does, a fresh competitor to the Mont Cenis route, unless further provision is made to retain the traffic to France by the provision of better connections.

In a recent paper in *Le Génie Civil*, M. Louis Lafitte discusses the whole situation, and shows how it may be possible to turn what at first appears to be a serious inroad into the railway business of France into an addition to her transportation facilities between central Europe and the transatlantic ports.

With the first piercing of the Alps by the Mont Cenis tunnel the traffic from Italy passed directly into and through France to French ports, but the completion of the St. Gothard route, assisted, it is maintained, by German influence and financial aid, diverted much of this business from France, and assisted in the development of the commerce of Genoa and the North Sea ports, to the disadvantage of Marseilles. By the St. Gothard route Genoa was placed more than 100 miles nearer to Bâle than is Marseilles, and the result of this advantage has distinctly appeared in the relative growth of the business of the two cities, that of Genoa increasing much more rapidly than that of Marseilles. With the completion of the Simplon tunnel the advantage of Genoa over Marseilles will be still greater increased, unless some modification in French railway connections is made to modify the traffic conditions.

In discussing the general rearrangement of transport relations which may be made consequent upon the completion of the Simplon tunnel and its connections, M. Lafitte examines profiles of the different routes by the Mont Cenis, St. Gothard, and Simplon, showing the additional construction which must be made if the connection between Milan and Paris is to be improved. Three routes are examined, first by way of Pontarlier, and Lausanne to the Simplon; sec-

ond, by Bellegarde and Saint-Gingolph, also to the Simplon, and third, by Lons-le-Saunier, the Col de la Faucille, and Geneva, connecting direct with the Simplon-Jura railway through the Simplon tunnel to Milan and the Italian railway system. All three of these routes materially shorten the distance over the existing connections by Mont Cenis or by the Saint Gothard to Paris, but the last of the three is the one especially advocated by M. Lafitte. Summing up its advantages, he says that it would reduce the distance between Geneva and Paris from 605 kilometers to 488, or 20 per cent., while the total distance between Paris and Milan, now 1,441 kilometres by the Saint Gothard route, would be reduced to 1,039 kilometres by the combination of this connection and the Simplon tunnel route, a gain of 402 kilometres. This latter corresponds to a reduction of fully two hours in the time between Paris and Brindisi for the Oriental mails.

But, in the opinion of M. Lafitte, the shortening of the connections between Milan and Paris is but a portion of the benefit to be gained by the opening of a direct French connection to the Simplon tunnel route. The true advantage to be gained includes the opening of a trunk line across France, connecting Switzerland, Italy and the Adriatic with an Atlantic port on the coast of France. Such a port he finds in Saint Nazaire, at the mouth of the Loire. Given the proper railway connections, such as would be obtained by the construction of the connecting portion through the Col de la Faucille to Geneva and the Simplon, the port of Saint Nazaire would become to France what Hamburg and Bremen are to Germany, offering a direct communication to transatlantic navigation which would make France the most advantageous country through which to make communication with the whole of southern Europe.

At the present time there is no complete railway system across France, all the lines running to Paris and communicating to the North Sea ports, while the narrowest part of the country really offers the most direct route for connection to the sea. The railways for this cross-country are already in existence, and it requires only the construction of the short connection through the Col de la Faucille to bring the Paris, Lyons, Mediterranean line into a close working union with the Simplon-Jura system, together with the establishment of trunk line relations with the remainder of the system, to place France in complete command of all the advantages which will arise from the completion of the Simplon tunnel.

Until now the gain to be expected from the piercing of Monte Leone has been ex pected to follow from the shortening of the distance from Milan to Calais, Ostend, and the coast of the North Sea, and the advantage thus given to Genoa has been expected to work injury to France by the effect upon the traffic of Marseilles. If, however, the line proposed by M. Lafitte, and called by him the "Grand Central Railway of Europe," be constructed, France will be the principal gainer by the Simplon tunnel, even though the trade of Marseilles with the north is undermined.

A feature of this proposed route which appeals especially to the French imagination, is the fact that it would provide an "all-Latin" communication to the Orient. Connecting directly with Italy through Latin Switzerland, all passage through Germany would be avoided, and it would become possible to compete to material advantage with the present "Orient-Express" route by way of Strasburg, Munich and Vienna.

The paper of M. Lafitte shows in an interesting manner the extent to which facilities create traffic. When the Mont Cenis tunnel was completed it was assumed that it would be able to take care of the travel between France and Italy for many years. Soon, however, the Saint Gothard tunnel was built and ample business appeared for both routes, while the increasing demand for communication through the Alps has led to the expenditure of millions in the piercing of the Simplon. Already before the passage is opened the anticipated traffic is offered as an incentive for the opening of additional railway routes from the tunnel to the sea, and even if the plans for a new central route through France are not at once executed, it may well be expected that the connections with lines already existing will find ample business. Under such circumstances the time will soon come for the enlargement of the auxiliary Simplon tunnel and the opening of the double track.

POSSIBILITIES OF LIQUID FUEL.

THE ECONOMY OF INTERNAL-COMBUSTION MOTORS USING LIQUID FUEL IN COMPARISON WITH STEAM ENGINES AND BOILERS.

Rudolph Diesel—Verein Deutscher Ingenieure.

LIQUID fuel is continually coming in for more and more attention, both as used under boilers for the generation of steam and for combustion directly in the cylinder of the internal-combustion motor. The former aspect of the subject has been dealt with fully in the pages of this magazine by Professor Williston, and now in a paper by Mr. Rudolph Diesel, in the *Zeitschrift des Vereines Deutscher Ingenieure,* is given the latest information concerning the latter portion of the question.

The work which Diesel himself has done in the development of the oil-burning motor is well known. Taking the theoretical cycle of Carnot, he has designed an engine which reproduces in a close degree the same succession of thermodynamic events, with the result that the highest known thermal efficiency has been realized in motors of his design. Furthermore, by the employment of very high degrees of compression, he has succeeded in securing such a complete combustion that heavy petroleum residues are burned as fully and completely in the cylinder as are the most volatile essences, the thermal efficiency being equally high for all kinds of liquid fuels.

But it is not intended here to re-discuss the Diesel motor. In his latest paper Mr. Diesel examines the broad subject of the direct use of liquid fuel in internal-combustion motors, and shows that its rapid growth during the past five years renders it a notable question in the domain of power generation.

Taking the thermal efficiency of the best modern triple expansion steam engine, using high pressure and superheating, and considering this as unity, we have the following comparisons for internal-combustion motors. The gas engine, using lean furnace gases, has a relative efficiency of 1.27; the so-called "spiritus" motor, using the light, volatile hydrocarbons, as in many automobile vehicles, stands at 2.08; while the Diesel motor, burning heavy crude oils directly in the cylinder, without employing anything corresponding to the carburetter, has a thermal efficiency of 2.27. Comparisons based on the relative costs of the different fuels naturally adds to the advantage possessed by crude petroleum, paraffine, and other heavy oils, and hence the economic efficiency of the Diesel motor is even higher when considered upon a commercial basis than when the thermal efficiency alone is taken.

As Mr. Diesel clearly points out, the question of the efficient use of fuel in the generation of motive power has become something far greater than the mere matter of saving a certain proportion of operative cost. It is rapidly becoming a controlling element in establishing the location of commercial centres. There is little doubt that the economic importance of Great Britain, apart from her geographical position and maritime strength, has been largely due to the possession of abundant stores of coal. With the increasing cost of that fuel the necessity for greater efficiency in its use is beginning to be realized. At the same time the advent of motors burning liquid fuels with a thermal and commercial efficiency of more than double that of the best steam engine is naturally strengthening the competition with countries possessing abundant stores of petroleum. In the recent discussion of the paper upon the Diesel motor by Mr. Ade Clark at the Leeds meeting of the Institute of Mechanical Engineers, the success of the motor in England was shown to depend, to a great degree, upon the cost at which the liquid fuel could be delivered at the point where the power was to be generated. This being the case, the tremendous advantage of locations, such as south-eastern Russia, western Pennsylvania, Texas, southern California, etc., naturally appears. Mr. Diesel gives in his paper a map of the world, upon which the present centres of natural supplies of petroleum are indicated, and a study of this map reveals the fact that certain places would necessarily assume much greater importance industrially than they

now possess if their natural supplies of liquid fuel were directly applied to power generation.

It has been argued that the general use of liquid fuel would tend to defeat its value industrially by forcing the price up, by reason of the increased demand, so that it would no longer offer the great commercial advantages which may now be shown. To a certain extent this contention may be admitted, and if the natural supplies of liquid fuel were wasted as lavishly as were the stores of natural gas in the United States during recent years there might become a shortage in the supply. Even when burned under steam boilers in properly designed furnaces, the inherent low economy of the steam engine would cause the oil to be consumed more than twice as rapidly as in a motor of the Diesel type, so that to a certain extent the development of the natural supply of liquid fuel should go hand in hand with that of the internal-combustion motor.

There is little doubt, however, that the natural resources of petroleum are by no means all exploited, and there is every reason to believe that with increased applications the work of exploration will go on and that many parts of the world as yet unworked reveal supplies of oil available for motive power. It is altogether possible that the supply of liquid fuel exceeds in quantity that of solid coal, and as a large portion of the world's supply of solid fuel has been wasted by reason of the low economy of many of the earlier forms of engines and boilers, it is interesting to know that the beginning of the employment of oil-fuel directly in special forms of motors is being conducted in a far more scientific manner.

One of the most important applications of liquid fuel which may be made is for marine propulsion, the conditions for the advanatgeous combustion of solid fuel there being especially difficult by reason of the limited space available for installation and operation of the machinery. With all the space now occupied by steam boilers given over to the arrangement of the engines, and with all the labor attendant upon coal passing, ash removal, and firing avoided, the question of increased powering of vessels may be found to depend to a great extent upon the introduction of liquid fuel. There is probably no more exhausting form of labor than the firing of marine boilers, and with the increasing demands for size and speed this portion of the problem is demanding a solution which appears to have been found in the substitution of oil for coal. The fact that oil is all combustible does away with any consideration of the handling of ash, while the higher calorific power of oil over coal renders the space devoted to storage of fuel a simpler problem to be met. These and many minor points indicate that the marine type of internal-combustion motor offers points for most serious consideration, and it is greatly to be hoped that the experiences which have already been had may lead to their extension to much larger applications.

A GERMAN VIEW OF AMERICAN INDUSTRY.

IMPRESSIONS OF A GERMAN ENGINEER GAINED IN A SPECIAL TOUR OF INVESTIGATION OF THE MACHINE SHOPS OF THE UNITED STATES.

Paul Möller—Verein Deutscher Ingenieure

THE question of the relations of the American mechanical industries to those of Germany, and the possibility of increasing competition has led to a serious consideration of the subject from a technical as well as from a commercial standpoint. For this reason the *Verein Deutscher Ingenieure,* representing as it does the mechanical engineering profession of Germany, recently arranged a special tour of the manufacturing establishments of the United States, sending as a delegate of the society Herr Paul Möller, to examine and report upon the general condition of technical and mechanical methods in America, with especial reference to the extent to which those methods entered into international competition. Those who had the privilege of meeting Herr Möller can testify to the energy and judgment with which he conducted his task, and the manner in which he was welcomed and

permitted to examine the workings of many of the most important establishments in the United States is evidence of the degree to which his report embodies the general scope of the investigation.

At the time of the presentation of Herr Möller's report, at the recent meeting of the *Verein Deutscher Ingenieure* in Augsburg, the account which he gave of American machines, processes and methods was received with close attention, and the opinion of the society was undoubtedly truly expressed by the President, Herr von Oechelhäuser, when he said that they had assuredly sent the right man.

Herr Möller first compares the natural resources of the United States with those of Germany and of Great Britain, showing by graphical diagrams the enormous output of grain, coal, iron, and petroleum in America, and the rapid rate at which these materials have been produced in recent years. The comparatively high rate of wages paid in the United States also comes in for consideration, the comparison of this, however, being made upon a time basis rather than upon the actual results produced.

Taking these two factors into account, it appears that corresponding requirements appear to affect American manufacturing industries. In the first place, the constantly increasing demand for the products compels the adoption of everything which tends to increase the output; and in the second place, the high wage rate requires the use of as much labor-saving machinery as possible, in order to cut down the labor cost of the product.

One of the first impressions which American methods make upon a foreigner is the high degree of differentiation existing in the machine industries. In the large workshops of Europe one finds the same establishment building stationary and marine steam engines, pumps, hydraulic machinery, rolling mills, sugar machinery, etc., etc., while in the United States few such general establishments remain. Instead, one finds one shop building only lathes, another only boring mills, another steam engines, and, indeed, there are some shops which limit their work to one machine only, making but a single size, and devoting every energy to the perfection of this unique product. It is this differentiation of products which renders the employment of standard sizes and special tools possible to the highest degree. From this subdivision of products the system of mass production has developed, so that even large articles, such as pumps, steam engines, and similar machines are made by the dozen, or even in larger lots, this enabling material reductions to be made both in the elements of time and of cost. As an example of pass-production, Herr Möller cites the railway-motor shop of the Westinghouse shops at Pittsburg, where the various parts are delivered and machined in quantity, these coming in from both ends of the long building and being erected in the middle, and delivered to the warehouse on one side, the work proceeding in almost a continuous flow.

Naturally, much of the interest of a foreigner in American shop methods appears in the account of the various special tools in general use, as well as in the extensive employment of jigs and special gauges, these removing from the workman much of the old-time "laying-out" of work upon which so much time was formerly expended. Apart from the saving of time effected by these appliances, the avoidance of error and the interchangeability of products make the modern plan of great advantage.

The higher wage rate necessarily involves the necessity of using machinery as much as possible for the handling of material, and in nearly all modern shops will be seen not only travelling cranes, but also overhead rails carrying portable hoists and large areas are thus covered rapidly and effectively by the efforts of but a few men. Individual tools are equipped with their own cranes, while small railways traverse every part of a shop, traction being effected either by steam or by small electric locomotives. Many of these things are well known in European practice, and the main difference which appears to a visitor in America is the generality of such appliances, and the rarity of the gang of slow-moving laborers, painfully performing unskilled labor which a machine could do better and more rapidly.

Herr Möller soon found that an investigation of American establishments would

be incomplete if limited to the inanimate appliances of the workshop. It has been said that American workmen are more efficient than those in the workshops of Europe, but it is well known that a large proportion of the best workmen in America are of British, German, and other origins, so that the difference, if such exists, must be due to something other than race characteristics. Some have attributed the greater activity of workmen of all races to the stimulus of the American climate, but Herr Möller finds ample cause in the better payment and in the lesser use of alcoholic stimulants.

The ambition of the American workman leads him to realize that his social position depends solely upon himself, and that he may make of himself what he will. With this is found the possibility of making the earnings depend to a large extent upon his own individual efforts, and the extent to which the various forms of remuneration, such as the premium and bonus systems, and the improved piece-work and contract systems, are used shows that the true principles of economical operation lies in the measurement of value by results instead of the older method of time payment.

Herr Möller touches briefly upon the questions of labor unions and of trusts, both representing the extremes of association on the part of the workman and the capitalists, and shows that upon the exercise of good sense and reason on the part of both sides the industrial prosperity of the country depends.

Coming to the question of the applicability of American methods to the German shops, it is rightly said that the conditions are too widely different in the two countries to permit of blind copying by one nation of methods which have proved effective in the other.

In numerous instances valuable points may be interchanged, but in general the demands of the varied markets of Germany render it impracticable to produce large quantities of uniform products with the consequent advantages of automatic machines and repetitive methods. The so-called American invasion is not to be belittled, but neither is it to be overestimated. The best plan for Germany to meet the competition is not blindly to imitate methods which themselves are the consequences of their environment and special conditions, but to devote increased attention to the methods which have done so much for Germany in the past and which are so deeply rooted in her soil. The development of the native workman, with proper technical training, and with ample opportunities to exercise his abilities, will enable Germany to hold her own and to maintain the position which she has already attained among the industrial nations of the world.

MATHEMATICS AND ENGINEERING.

A DISCUSSION OF THE EXTENT TO WHICH THE PRESENT METHODS OF TEACHING MATHEMATICS ARE USEFUL TO THE ENGINEER.

A. P. Trotter—Engineering.

MATHEMATICIANS may be divided into two classes, those who study the subject for its own sake, and those who desire to obtain some useful results. Sometimes a man belongs to both classes, but usually membership in one forms a bar to the other, although both are open to all. Just at the present time the men who think the useful side is the only one are very much in evidence, and articles on the proper method of teching mathematics, so that the engineer and the practical man may get some decent service from the knowledge, are met on every side. A very interesting treatment of this phase of the subject appears in a recent issue of *Engineering*, Mr. A. P. Trotter discussing useful mathematics from the engineer's point of view in a manner which invites comment and review.

There can be no doubt that from the standpoint of the engineer much of the mathematics now taught is useless. All he wants to know is the ordinary method of making computations for every-day work, together with such moderate amount of algebra and trigonometry as will enable him to make occasional excursions into experi-

mental fields. If he has any really thorough investigations to undertake he engages what Mr. Trotter calls a "tame mathematician" who doubtless knows his mathematics well, but who usually has little or no knowledge of the real subject in hand or the data upon which it is based.

"Mathematics as means to an end are of incalculable importance to engineers, not only for the advancement of their work in the future, but for the daily needs of the office or the shops. Take logarithms, for example. Is one engineer out of five hundred interested in learning, or justified in burdening his memory with, the fact that the logarithm of a number to a given base is that power to which the base must be raised to give that number? An engineer needs logarithms simply to save time in calculation, and generally for mere arithmetical purposes. He would no more dream of making a logarithm than of making a watch. A watch is to him no less useful, and his handling of it is no less intelligent, because he has not the dexterity to make one. Mathematics are destined to be of increasing value to engineers, and the mathematical education of engineers will be carried further than at present when such lumber as Euclid has been thrown overboard."

One of the principal difficulties with the application of the mathematics learned at school to the problems which the engineer has to solve is found in the utterly impractical nature of the examples with which the ordinary text books are filled. Most of these examples have been evolved out of the inner self-consciousness of the writer of the book, he himself having had no practical experience whatever; and their solution includes the omission or "neglecting" of some of the elements which the engineer finds it most essential to include. Such matters as friction, heat losses, atmospheric resistance, etc., are often considered as altogether unworthy of mathematical attention, while their presence and magnitude may really be the controlling features of the practical problem.

Again, the insistence of a high degree of precision in results when the original data may be altogether lacking in accuracy acts to repel the intelligent engineer from the formal mathematician who cannot realise the working limitations of materials and processes. In some cases a great degree of precision is demanded in engineering problems, and in such cases the engineer has not been found lacking, as witness the success which has attended the construction of the highest grade of astronomical instruments by a well-known firm of machine-tool builders. When, however, the loads on a bridge can be estimated only to the nearest ton, and the strength of the material may vary in every member, it makes the engineer very weary to have the mathematician insist upon employing algebraic methods to compute the stresses to the hundredth of a pound.

More and more the engineer is using mechanical methods to relieve himself of the labor of computations, and the increasing use of the slide rule, the planimeter, the mechanical integrator, and all the methods of graphical analysis show the feeling of the working engineer as regards the routine methods of mathematical work.

At the same time the engineer is really more of a true mathematician at heart than many of the skilled analysts who look on him as a mere kindergarten pupil. It has been well said that theory takes into account all the conditions which appear, but that practice has to take into account all the conditions there are, and the very points which the mere theorist has seen fit to neglect, or probably has not seen at all, may be the very ones which actually control the final result. It is well known that the principal difficulty in getting a satisfactory solution of a practical question from a trained mathematician is that of overcoming his inability to grasp all the conditions of the case, his general desire being to compel the problem to fit in with some one of his previously conceived examples.

That there is a place for the modern higher mathematics no one is more willing to concede than the engineer, and he more perhaps than any one else, understands that the abstract researches of one generation become the working methods of the next. It is only the tendency to misapply methods and processes to which he objects, and this tendency being absent, he welcomes the study of pure mathematics for those who have the capacity to grasp them and the time in which to make the study.

There is undoubtedly a present demand

for such a system of instruction in general mathematics which shall be adapted for the use of the present and prospective engineer, but such instruction must come from those who are themselves practical engineers and who have grasped the needs of the situation from their own working contact with the problems of the day. The language should be that of the workshop and the field, the examples must be drawn from the problems with which the mechanic and the designer is daily confronted, and the methods must be such that the man who has already grasped the behaviour of the forces under consideration shall see those forces treated intelligibly, without any shirking of the results which he has found by bitter experience, must be encountered.

It has been said that the skillful engineer and mechanic must always be a truthful man because he knows that deceptions cannot be practiced when the actual work is assembled. He cannot force a balance and make two things which are unequal look equal by saying so in some juggling fashion. For him the sum is always equal to the total of all its parts, and if he has erred in the dimensions or arrangement of those parts the truth will out to condemn him.

A school of mathematics for such men must be something different from that which is now taught, and when such a system is forthcoming the engineer, of all men, will give it grateful welcome and use.

RESISTANCE OF ROAD VEHICLES TO TRACTION.

INFLUENCE OF ROAD SURFACES, GRADES, TYRES, AND MATERIALS UPON THE RESISTANCES TO AUTOMOBILES AND OTHER VEHICLES.

Report of British Association Committee.

AMONG the interesting communications presented at the Southport meeting of the British Association for the Advancement of Science may be noted the report of the committee to whom was entrusted the investigation of the influences of roads to the motion of vehicles.

The absence of reliable data upon this subject, and its growing importance in connection with the development of automobile vehicles renders scientific determinations under acual conditions most desirable, and the report, so far as it goes, has added materially to the stock of information.

After describing improvements which had been made in the traction dynamometer with which the tests were made, the report goes on to describe experiments made upon iron tyres on wheels operated at various speeds and under different loads. These trials, made on a level road paved with stone setts, 6 in. by 3 in., with spaces of one inch between them, gave results which when plotted as curves furnished some interesting information. Thus, in each case the resistance increased with the velocity, but at a diminishing rate, the curves having a concave side downward. This may be due to the fact that as the wheel travels faster it has less time to fall into the little hollows in the roadway, merely skimming along the tops of the ridges. This view is borne out by the experience of riders on bicycles, who know by experience that a road paved with stone blocks is less rough when traversed at a high speed than when a slower pace is maintained. Comparisons of the resistance curves for stone blocks and for macadam show that a smaller tractive effort is required for the former than for the latter. Upon investigation the reason for this is apparent. Consider two perfectly level roads, one made with setts and the other with macadam. The setts present a surface which is extremely hard, although possibly irregular, but this irregularity with well-laid setts is more apparent than real, as the tops of the setts themselves are smooth and level and all in the same plane. On the other hand, the macadam, although quite level, is not nearly so hard as the stone surface, and is, moreover, covered with a thin layer of dust or fine gravel, which, as well known, retards the progress of a vehicle.

The experiments with iron tyres showed that for a 40-inch wheel with 3-inch face, the resistance was about 25 pounds, when running at a speed of 6 miles, and carrying a load of 672 pounds; while the same wheel showed a resistance of 35 pounds at 10 miles, and about 38 pounds at 12 miles speed, similar results being obtained with other loads.

Similar experiments were made with pneumatic tyres, the wheel in this case being a light wire-spoke wheel, 24 in. in diameter with 2¾ tyre; these trials being made upon a level macadam road in fairly good condition, the results being plotted in curves.

With these experiments it appears that the ratio of tractive effort to load is very nearly constant, and that the tractive effort increases but slightly with the velocity, the lines being almost straight, with a small angle with the horizontal axis. From these trials a diagram for the tractive effort per ton for different velocities has been made, this showing a resistance of 128 pounds per ton at 7 miles per hour, and 148 pounds at 16 miles, the resistance increasing at a rate of a little less than 2 pounds per mile. By taking the resistance as directly proportional to the load and inversely proportional to the diameter of the wheel, the value for other operative conditions may be computed. The real relation between wheel diameter and tractive resistance is not exactly known, but the above rule agrees with the experiments of Morin, and may be considered as fairly near the truth.

The much discussed subject of the benefits of wide tyres is also considered, this having been especially examined by Mr. Diplock, one of the members of the committee. He started with the following assumptions:

1. All wheels are coned or straight in cross-section.

2. All roads are arched or flat in cross-section.

3. It seems evident that coned wheels on flat roads or flat wheels on arched roads cause increased road resistance in proportion as the wheels are coned or the roads arched in relation to each other, and that the same result is caused by inequalities in the road surface, viz.: that wide tyres do not obtain an even bearing throughout their entire width, except on very soft and yielding ground.

Starting from the above statements, and as the results of long experience and observation, he had come to the conclusion that for heavy traffic wheel tyres of more than, say, 9 in. in width, have, in practice, little or no material value as tending to reduce road resistance or damage to the road surface, and he suggested that experiments might be carried out with a view to testing the accuracy of this conclusion.

Assuming that 9 in. were adopted as a useful maximum width of tyre for heavy haulage on average roads, he submitted the following theory:

1. That the supporting power of a road is limited by the cohesive friction of the road molecules or particles against each other.

2. That this supporting power limit varies very considerably according to the material used in constructing the road and the moisture absorbed in the road.

He would be prepared to find that road resistance up to certain limits of weight on each wheel (for each class of road) varies approximately in direct proportion to the increased weight on each wheel.

He was of opinion, however, that if this limit of weight per wheel is exceeded so as to overcome the frictional cohesion of the road molecules against each other, then an entirely new set of conditions arises; and he would be prepared to find that road resistance would, under such conditions, increase altogether out of proportion to increased weight on the wheels.

He urged that the committee take steps to ascertain:

1. The maximum useful width of tyre for heavy traffic on average roads.

2. The limit of weight on each wheel (for various classes of road) up to which road resistance increases in direct approximate proportion to the increase of weight on each wheel.

3. The rate of increased road resistance when that limit is moderately exceeded.

The report also includes some interesting information gathered at the recent international congress of automobilism in Paris.

Experiments made by M. Jeantaud with a electric vehicle gave results which are eminently practical, since the resistance was determined by measuring the electrical energy required under actual running conditions. With a vehicle operating with a load about 4,000 pounds, 1,760 watts was required to maintain a speed of 9.32 miles per hour, and making an allowance of 15 per cent. for motor friction the energy of propulsion was 1,496 watts. Working this out in English units a tractive effort of 46 pounds per ton is obtained.

Other experiments by M. Jeantaud upon

roads in various conditions show the influence of the surface upon the resistance. Thus upon a muddy road, with the same vehicle and under conditions otherwise similar to the above, a tractive effort of 74 pounds per ton was measured. The same road, when very smooth, and hardened by frost, offered a resistance of only 42.7 pounds per ton, and in general the resistance of a muddy road appears to be about double that of a smooth, hard road.

The question of the powering of automobiles naturally is included in the discussion of the resistances which the power must overcome, and in this respect some interesting points have been developed. Acting upon the principle that dead weight is to be avoided, the builders of vehicles have endeavored to reduce the weight of their machines per horse power developed, and a marked progress has been attained in this respect. Thus, according to M. Lavergne, the run from Paris to Bordeaux was made by Levassor in 1895 in a 4 horse power car weighing about 1 ton, or 1 horse power for 550 pounds dead weight. In 1896 this weight was reduced to 365 pounds per horse power, and by 1900 it had fallen to 90 pounds.

In the recent Paris-Madrid race, one car entered was of 100 horse power, the weight of which represented only 22 pounds per horse power, and in the case of motorcycles this has been still further reduced.

It is a question, however, whether such a reduction in weights is wholly advantageous. Apart from the narrow margin of safety which is allowed, and the Paris-Madrid fiasco showed how close this margin was, a certain proportion of weight is necessary for traction.

An extremely powerful motor must be accompanied by a comparatively heavy load, otherwise the wheels do not bite well, and energy is wasted. As M. Lavergne well says: "Instead of building very powerful, yet extremely light motors—the durability of which is questionable—would it not be better to rest content with a vehicle of smaller power, and use it more effectively?"

An important matter in connection with the investigations of the committee appears in the announcement that negotiations have been made by which experiments conducted upon heavy traction vehicles by the Mechanical Transport Committee of the War Office will be placed at the disposition of the Association, so far as this work may relate to matters other than military. It is to be hoped that in this way much valuable information will be gained to form matter for future reports.

THE ACTION OF SEA WATER ON ALLOYS.

EXPERIMENTS UPON THE CORROSION OF COPPER, IRON, AND NICKEL ALLOYS BY PROLONGED CONTACT WITH SEA WATER.

Investigations of the German Navy.

SEVERAL years ago we discussed in these columns the investigations made by Chief Engineer Diegel, of the German Navy, upon the corrosive action of sea water upon different bronze alloys after prolonged immersion. We now quote results by the same experimenter, and from a recent issue of *Glasers Annalen* we abstract some account of the work which has been continued.

The previous experiments were made especially with copper alloys, containing zinc, tin, and aluminum, the specimens being taken from the metals practically used for the sheathing of vessels, and the tests included immersion in sea water for 2 to 2½ years. The general result of these experiments showed that an important influence was exerted by the material with which the sheathing was in contact, there being a distinct galvanic action. The relative position of attached metals in the galvanic scale appeared to govern the rate of corrosion, and metals which resisted well when in contact with those which were electro-negative towards them, became rapidly corroded when in contact with electro-positive metal.

In the present investigations the question of the influence of the purity of the material upon the corrosive action is considered, and the extent to which the presence of impurities retards corrosion is studied. Thus specimens of electrolytic copper, 99.955

per cent. pure, were immersed in sea water beside pieces of ordinary commercial copper, this latter being 98.98 per cent. pure, and containing 0.6 per cent. of arsenic. The pure copper was rapidly corroded, the metal being eaten away fully 13 times as fast as was the impure specimen. It might be supposed that the two specimens formed a sort of galvanic couple, the pure copper becoming an anode, and consequently eaten away, but further experiments upon the hulls of two boats, one sheathed entirely with the pure copper and the other with the common material showed similar results. At the same time it could not be supposed that no galvanic action took place under these latter circumstances, so further experiments were made, with interesting results. Thus, the marked difference in the corrosion of rods of pure and impure copper disappeared when the two specimens were electrically insulated from each other. Also when a sheet of electrically pure copper was allowed to become oxidized in spots before immersion in the sea water, the bare portions were soon deeply eaten, thus showing that the copper formed a galvanic element with its own compound, the pure metal becoming the anode and consequently the portion to be attacked. The fact that homogeneity played an important part in the action was shown by the fact that annealed copper was far less rapidly corroded than hard-drawn metal having a much higher resistance and elastic limit.

Coating the copper with zinc, commonly miscalled galvanizing, protects it for but a short time, and as soon as portions of the zinc are worn off the corrosion proceeds more rapidly than ever. Contact with iron, however, causes the copper to be much less rapidly eaten than when it is immersed alone in the sea water.

Herr Diegel examines the conditions under which copper pipes on shipboard are corroded, and in view of the extensive use which is made of copper connections on modern vessels, this portion of his investigations are of especial importance.

Corrosion usually takes place in the inside of pipes, and an examination of pipes which have been in service reveals a variety of effects, thus complicating the determination of the causes. Thus in some cases there will be a general pitting over the whole interior surface, while in others the corrosion is confined to grooving and cutting in limited portions. Especially is this action found at points where the pipe has been highly heated for the purpose of brazing on flanges or other connections.

In general the causes of local corrosion in pipes may be sought among the following: namely, the use of a variety of kinds of copper in the original construction; the admittance of air into the interior of the pipes; or the production of electrolytic action.

A chemical analysis of the material of copper pipes which had been in service on a number of ships revealed the following facts: Pure copper is, in general, more rapidly corroded than metal which contains impurities, the ordinary commercial material being acted upon less rapidly than electrolytic copper. The presence of oxide in the copper increases its liability to corrosion. Apparently the presence of arsenic in the copper hastens the corrosive action.

So far as the action of air is concerned, it operates indirectly, by causing the formation of spots of oxide, creating galvanic couples, and thus promoting corrosion. The presence of arsenic in such cases appears to retard the corrosion.

Electrolytic corrosion, due to the action of stray electric currents, forms a most formidable clause for the weakening of copper pipes, and this should especially be guarded against on shipboard by having all return circuits carefully maintained.

The usual protection against the corrosion of copper pipes is the attachment of pieces of zinc, this metal taking the character of an anode to the copper, and itself being corroded by the galvanic action thus produced. This protective action would be best produced if the zinc could be placed in the form of an insulated rod running the entire length of the pipe, but this is hardly practicable in actual service. An objection to the use of zinc is found in the danger of excessive corrosion being produced at the points where the corroded particles of the metal fall upon the inner surface of the copper.

Herr Diegel appears to think that greater safety may be obtained by the use of certain alloys instead of attempting to employ ordinary copper pipes, and he has made

numerous tests with different alloys of copper, nickel, zinc, and iron. In order to compare the value of the copper-nickel alloy, comparative trials were made with tin, iron, and aluminum bronzes, the copper-nickel alloys tested containing from 18 to 42 per cent. of nickel. Rods of the various metals were suspended in sea water for 25 months and tests being made before and after the immersion to effects of the water upon the strength were seen. Without going into the details of the tests, which are fully given, both in diagrams and tables in the original paper, the general result was favorable to the nickel copper alloy. The action of the water was distinctly affected by the other materials with which the nickel-copper alloy was associated, the nickel-copper being protected to a greater or less extent at the expense of its neighbors. Thus the iron-bronze was deeply corroded and the nickel-copper correspondingly protected, which similar actions to a less degree occurred in connection with the other bronzes.

Experiments were also made upon nickel-steel alloys, and the ill effects of placing ordinary steel castings in association with nickel-steel in contact with sea water was clearly shown. Similar effects were produced by the association of pieces of iron containing different percentages of phosphorus, the portion containing the lesser proportion of phosphorus forming the anode and being corroded, while at the same time protecting the portion containing the higher percentage of phosphorus.

RECENT EXPERIMENTS IN GLIDING FLIGHT.

LATER EXPERIENCES WITH SOARING AEROPLANES AND KITE MACHINES IN CONNECTION WITH HUMAN FLIGHT.

Wilbur Wright—Western Society of Engineers.

IT has been well said that a man might spend a lifetime in studying the equilibrium of forces in connection with riding a bicycle, and yet be no nearer the ability to ride at the end than he was at the beginning. It is more than probable that the same is true with regard to aerial navigation, and even with the aid of inflated gas bags for support the experiences of Santos-Dumont and others has demonstrated that proper balancing is a large element in success.

About two years ago we reviewed in these columns the experiments of the Wright Brothers in connection with gliding flight, and gave some account of the success which had been attained in the support of the human body by means of aeroplanes of improved construction, employing only the supporting power of air currents. We now have another paper, presented before the Western Society of Engineers by Mr. Wilbur Wright, and published in the *Journal* of the society, detailing later experiments in the same line, with much interesting practical information, showing the extent to which individual experience in balancing and automatic control enters into success.

The machine used by the Wrights consisted of a form of box kite, the latest model being a double-deck machine, having two surfaces, each 32 feet from tip to tip and 5 feet from front to rear.

The total area of the main surfaces was about 305 square feet and the front rudder added to this about 15 square feet, while the vertical tail was originally 12 square feet, afterwards reduced to 6 square feet. The weight of the entire machine was 116½ pounds, and including the operator the total weight sustained was from 250 to 260 pounds.

Mr. Wright describes a number of experiments which have been made with this machine, mainly in connection with soaring, the preliminary trials having been made with the apparatus as a kite, without an occupant, in order to determine the angle at which soaring could best be maintained. By soaring is meant not only that the weight of the machine is fully sustained, but also that the direction of the pressure upon the wings is such that the propelling and the retarding forces are exactly in balance. Under these conditions the resultant of all the pressures is exactly vertical, and there is no unbalanced horizontal component. The photographic illustrations to Mr. Wright's paper show

this condition very clearly, with the machine floating in the air and the retaining ropes exactly vertical. This result was obtained with the wind at an upward trend of 7 degrees, and further experiments with an occupant in the apparatus followed. One of the peculiar features of the machine is that the operator does not occupy an upright position, but lies nearly flat upon the lower sail, experience having shown that there is less disturbance to the equilibrium of the machine in this position than in any other, while the control is readily secured.

After some rather peculiar experience involved in acquiring familiarity with the steering mechanism, the experimenters appear to have been remarkably successful in making numerous gliding flights, and even in high winds the apparatus behaved well. The principal feature which was developed was the necessity for prompt, almost instinctive action in responding to changes in the wind. By long practice the management of a flying machine should become as instinctive as the balancing movement which a man unconsciously makes with every step in walking. The necessity for acquiring this experience made the operators keep close to the ground in their early flights, and often a glide of several hundred feet was made and a distance of but a few feet from the ground.

As Mr. Wright says:

"Progress is slow in the preliminary stages, but when once it becomes possible to undertake continuous soaring advancement should be rapid. Under special conditions it is possible that this point is not so far away as might be supposed. Since soaring is merely gliding in a rising current, it would be easy to soar in front of any hill of suitable slope whenever the wind blew with sufficient force to furnish support, provided the wind were steady. But by reason of changes in the wind velocity there is more support at times than is needed, while at others there is too little, so that a considerable degree of skill, experience, and sound judgment is required in order to keep the machine exactly in the rising current."

The importance of these experiments can hardly be overestimated, when it is realized that they show clearly that success in aerial navigation involves other elements than merely a correct construction. They demonstrate beyond doubt that an aeroplane can support itself and an occupant in the air merely by the action of the wind operating at a small angle, but they also show that unless the greatest skill and experience is available for guidance and balancing, the mere fact of support is useless. Nearly every designer of a machine intended to fly assumes that if only he can make his apparatus self-supporting success is assured. The example of the bicycle may again be called in, if only to remind us that the fact that the machine is supported by the ground is but one element in the problem of successful control.

If balancing and guidance are of such importance in simple gliding, as in the case of the Wright experiments, how much more important do they become when a self-propelled machine is considered. Instead of depending upon the wind for the supporting power, such a machine must be able to make independent headway, this adding to the complications of air currents and their irregularities, combining the artificial motion of the machine with the natural movements of the wind. It would seem, in the light of our present information, that the art of aerial navigation would be best advanced by the devotion of time and money to the development of skill in balancing and guiding, following out the experiments of the Wrights and others upon larger and larger scales, and bringing up this most important element in the problem to a state which would enable it to be treated constructively with the same scientific skill which has been expended upon the construction of light motors and other details. Such work would be far more profitable than the more showy performances which have been made of late with dirigible balloons, and would have a greater effect upon final success. It has been suggested that the gas bag might well be employed in such experiments as a temporary means of support, while the necessary experience was being gained with the aeroplane, much in the same manner as an air belt is employed in teaching the art of swimming. By some such means the artificial support might be gradually diminished and finally omitted altogether.

ENGINEERING AND POPULATION.

THE USE AND MISUSE OF POPULATION STATISTICS AS SOURCES OF DATA FOR MUNICIPAL ENGINEERING WORK.

A. Prescott Folwell—Engineering Record.

IN preparing plans for important engineering undertakings it is most essential that every care be taken to secure reliable data upon which all the subsequent work must be based, and frequently it is in the selection and determination of the original data that the experience and judgment of the engineer appears in the highest degree. Among such sources of information the determination of present and future population appear as of great importance, and hence the article by Mr. A. Prescott Folwell in a recent issue of the *Engineering Record,* upon the use and misuse of population statistics demands consideration.

Civilized nations have long since realized the value of population statistics, and efforts have been made in recent years to have what was at first only a numbering of the people extended to include commercial, technical, and physical information. At the same time so much depends upon the intelligent and conscientious use of such statistics that deductions are almost valueless unless they are accompanied with information as to the manner in which the census data have been used. To quote a well-known saying: "Figures will not lie; but liars will figure."

Mr. Folwell gives full credit to the efforts which are made to obtain accuracy in the United States census reports, but, as he well says:

"Too often a misuse is made of even reliable data, through ignorance or carelessness; the fact that the data have government authority too often giving a false sense of the reliability of all calculations based upon them. Many, even among engineers, are deceived and in some cases self-deceived, by such misuse; and it seems desirable to call attention to some of the more common forms of errors in the use of population figures.

"A common example is presented by water consumption reports. In the great majority of cases the per capita consumption of a city is given as the quotient of the total consumption by the total population, and these figures are compared for different cities, no account being taken of the number of consumers; whereas to be of any, or at least of the most, use the consumption per actual consumer should be given."

In many large cities the resident population of the active business districts is very small in proportion to the number of daily occupants, but it is the latter population upon which the engineer must base his computations for water supply, sewage, street cleaning, and other public works. It is in such districts that the water supply per capita becomes most misleading, since the great bulk of the consumption is that of the population which does not enter into the divisor, and the figures become meaningless.

"Statistics relating to the density and growth of city populations are often misleading, since in most cases the area of a city at a given census either embraces rural population, or does not embrace all of the urban, and the true density and growth of the urban are therefore not given. The limits of many cities in the South Atlantic States are defined as 'the circumference of a circle drawn from the court house as a center with a radius of —— miles,' this often including hundreds of acres of farm land on one side and excluding scores of blocks of urban residences on another. New York City's density in 1890 was 58.87 per acre, in 1900 it was only 16.43, the reduction being due to annexation of sparsely settled territory meantime, and not to any considerable change in actual density of any given area."

Mr. Folwell, however, rightly considers existing problems of this sort as matters which should be determined by the engineer upon his own observation for each specific case, and proceeds to examine the larger problems connected with the provision for the future.

"It is not only the present population, whose numbers concern the engineer; but it is generally realized that for many pur-

poses the future population must be estimated for ten, twenty or even fifty years. Examples of this necessity are found in designing sizes of sanitary sewers and of water mains, which should be ample for thirty or more years to come; in providing transportation facilities in large cities which shall be adequate for at least ten or twenty years; in determining upon the character of pavement to be laid (Kuichling has devised a formula in which the imperviousness of a pavement is made a function of density of population, in recognition of the fact that increase in such density is generally accompanied by increasing excellence of paving); and upon the size of blocks into which a given area is to be divided by streets, since densely populated and business districts should contain smaller blocks than should ordinary residence districts. In the majority of cases in the past such estimates of density as have been made have been upon the principle of "guessing at half and multiplying by two." Arbitrary predictions of 20, 40, 80, or similar numbers per acre are commonly made; in many instances the available funds are actually—sometimes confessedly—made the basis of size of water pipe or sewer, rather than the population. Such unscientific methods are unworthy of the profession when (as it is admitted is not always the case) any better ones are possible or practicable. Future population must generally be estimated from the present and its laws of growth in the past, with a consideration of the extent to which the laws of growth may be altered by future changes in economic or other conditions, and consequently past, present and future populations constitute one progressive problem."

For determining reliable ratios of past growth to use in predicting future requirements it is most desirable that the original data be carefully gathered and checked. This is only possible for the present data, but in some cases these results can be extended backward to check errors in past data by noting their variation from the present census information. Mr. Folwell gives formulas for use in such computations, and advocates the use of the method of differences as well as the plotting of curves in order to ascertain the probable future rate of increase.

In adition to all such mathematical methods the judgment of the engineer must enter into such predictions to a very large extent, since local influences, the beginnings of which may in some cases be already detected, may materially act to change the otherwise normal rate. The development of natural resources may act to increase the rate of growth to a degree which might otherwise be considered preposterous, while, on the contrary, the growth of business competition, changes in methods of production and manufacture, and the like, may cause a formerly prosperous and increasing place to be checked.

The whole subject is but another evidence of the broad scope of the work of the engineer, rendering him necessarily a sociologist and a close observer of nature and of civilization or of their close interrelation; a connection which it is the object of his profession to develop and increase.

THE HEAT TREATMENT OF STEEL.

RESTORATION OF DANGEROUSLY CRYSTALLINE STEEL TO ITS ORIGINAL PROPERTIES BY HEAT TREATMENT.

J. E. Stead and A. W. Richards—Iron and Steel Institute.

THERE is probably no one material of construction concerning which our notions have undergone more radical changes during the past few years than that most important substance known as steel. It is not so very long ago that the question was asked: "What is steel?" and even yet the question is but imperfectly answered. At least we know that it is a material of very varying properties, and that those properties by no means depend upon chemical composition alone, but that the physical structure may and does vary to a marked degree according to the heat treatment which the piece has undergone; and that the strength, toughness, and general usefulness of a structural member of steel may be largely controlled by the way in

which it is subjected to the action of heat.

Formerly it was assumed that phosphorus gave brittleness, sulphur made the metal red-short, and that the other properties were almost entirely dependent upon the proportion of the carbon content. With the introduction of the microscope and the use of the methods of metallography in the study of steel and other alloys, it has been found that the structure and the properties of the material may be largely modified without any change whatever in the chemical composition, and as a consequence some very practical lessons have been learned.

In a paper presented before the recent meeting of the Iron and Steel Institute by Messrs. J. E. Stead and Arthur W. Richards, the great practical value of the study of the effects of heat treatment upon steel is shown, especially in connection with the restoration of toughness and strength to steel which has been rendered crystalline by overheating or other improper treatment.

It has been completely demonstrated by the researches of Brinell, Tschernoff, Le Chatelier, Heyn, Ridsdale, Stead, and many others, that when steel or a coarse structure, but not necessarily brittle, is heated to a certain temperature and is then allowed to cool in air, or is quenched in oil or water, the original structure is destroyed, and is replaced by one of a very fine character. As recently as 1898 Mr. Stead showed that pure iron, when so coarsely crystalline as to resemble cast zinc, was restored to excellent qualities simply by heating to the critical point, so that it resembled the same iron in the condition in which it left the rolls.

The extensive use of steel for important structures, such as railways, buildings, bridges, and the like, renders it most important that only the best of material in the best of condition should be used, and the dangerous nature of crystalline steel is recognised by all as unfit for such purposes. For several years Messrs. Stead and Richards have devoted much time and attention to the study of the effects of heat upon the mechanical properties of steel, and have repeatedly succeeded in restoring dangerously crystalline steel in large pieces by simple heat treatment, obtaining material which would be accepted by any engineer as excellent. In view of the success of these experiments the account which has been given in the paper referred to is of especial value and interest, and some abstract of the method is here given.

Dangerously crystalline steel may be divided into three classes:

"The first class occurs only in mild steel very low in carbon and in pure iron; it is caused by annealing for a long period at too low a temperature in a slightly oxidising atmosphere. The second class, which is equally dangerously crystalline and is very common, is produced by long continued heating at high temperatures. The third variety occasionally met with is produced by heating the steel till it is practically burnt. In other words, to a point so near fusion that an evolution of gas occurs in the interior of the steel which separates the crystals from each other, so breaking up or making more or less discontinuous the whole mass. The metal in the third class, although greatly improved by heat treatment, can never be thoroughly restored by simply heating it; but in the case of the steel of the first and second classes, no difficulty has been found, by proper heat treatment, in making it equal and more often superior to the normal or forged steel which had been worked and finished at proper temperatures."

The experiments which are examined in detail in the paper were made upon steel rails of various sections, portions of the same rail being tested in the normal condition, after overheating, after restoring, and after a still higher heating. The temperatures were in all cases carefully taken by pyrometer, and the material was also analysed, and subjected to microscopical examination. The tests to which the material was subjected included the impact or drop test, tensile test, Brinell impression test, and vibratory-stress test, and the records of these examinations, both for the specimens taken from rails and those from large ingots are given in detail in the paper. The results fully bear out the theory, and show that when the material was originally of good quality it was fully restored by proper heat treatment.

The most essential feature which appears about the method is the demonstration of the fact that it is the temperature to which

has little or no influence upon the result. and not the duration of that temperature. The old idea of the process of annealing was that of reheating the material to a high temperature and holding it for a time at that temperature, and then causing it to cool very slowly, but the researches of Messrs. Stead and Richards show that the reheating must not exceed a temperature of about 900° C., and that the time of cooling has little or no influence upon the result Reheating and re-forging is an altogether unnecessary process, and, indeed, the material is very apt to be further injured by such a process. Since nearly any piece of structural steel is liable to be rendered more or less crystalline during the operations through which it is necessarily passed, it is most desirable that the process of restoration be made a regular portion of the routine of manufacture. To permit this it is only necessary that proper furnaces be designed to admit the large pieces and to permit a uniform temperature to be maintained in all parts, together with reliable pyrometers to enable the correct heat to be maintained, and the operation may be performed on every piece as the final stage in its manufacture. The result would be the complete elimination of danger or accident from weakness by crystallisation, thus removing the principal source of danger in modern metallic structures.

The following facts appear to have been fully established by the researches of Messrs. Stead and Richards:

"The microscope in each experimental series indicates the same result, that heating at high temperatures causes a great development in the size of the crystalline grains, and reheating to about 870 degrees restores the original or a better structure—see photographs C and D series.

"If all structural steels in their normal rolled or forged condition are good, they can be readily deteriorated in quality by heating to a temperature a little above that to which steel is most commonly heated previous to rolling or forging.

"Steel made brittle by such heating and dangerously brittle by heating at considerably higher temperatures can be completely restored to the best possible condition without forging down to a smaller size or by remelting.

"Practically all the results show that not only are the original good qualities of normally rolled steel, after making brittle, restored by the exceedingly simple treatment of heating to about 900 degrees C. for a very short time, but that such steel is made considerably better than it was."

WROUGHT IRON AND STEEL PIPE.

THE RELATIVE MERITS OF STEEL AND WROUGHT IRON AS MATERIALS FOR GAS AND WATER PIPE.

Engineering News.

ONE of the natural consequences of the concentration of administration, such as is constantly occurring by reason of the combination and consolidation of engineering and manufacturing industries, is the selection of certain materials and methods which show themselves to be adapted for general use, and the relegation of others to the background. In some cases this selection is naturally made for reasons connected with the economy of manufacture, either as related to economy of material or as dependent upon matters of mass production and the development of standard methods.

In a recent issue of *Engineering News* there appears a paper by Mr. Franklin Riffle, originally presented before the Pacific Coast Gas Association, upon the subject of commercial wrought iron and steel pipe, while in another portion of the same issue is a letter from Mr. John R. Freeman, the well-known hydraulic engineer, of Providence, R. I., discussing the same question from the point of view of the user; and both papers are of sufficient importance to be given more than passing notice.

The combination of the more important steel and iron works of the United States into one great corporation has been discussed in various manners, but there is one phase of the question which may well be mentioned in this connection. Formerly a customer ordered what he wanted, and

if one manufacturer could not supply it another was found who would. In most cases the various users of material settled down to the dealers who suited them best as to products and prices, and differences arose but infrequently. With the consolidation of the various manufacturing establishments came a desire to abandon the smaller variations in sizes, styles, and qualities, with a continual effort to unify production along certain broad lines from which all customers could draw their supplies. The soundness of this principle, as a general proposition, must be conceded, provided always that the quality and character of the products adopted were placed and maintained at such a high standard of excellence as would commend themselves to the user, and warrant him in so modifying his practice as to admit the standard product in the place of that formerly employed.

The case in question at the present time is that of pipe for the conveyance of water and gas. The standard article for this service has been made of wrought iron to dimensions and grades which have been so well settled by usage as to be practically accepted as permanent. It now appears, however, that the manufacturers are producing large quantities of steel pipe, and according to Mr. Freeman, are supplying it instead of wrought iron pipe.

Mr. Riffle, in his paper, to which reference has been made above, discusses the question openly from the standpoint of the manufacturers, and shows the advantages of steel as a material for pipe, in a detailed and definite manner. After examining the earlier methods of making butt and lap welded pipe, and touching upon the questions of pipe joints and screw threads, he proceeds:

"The crowning achievements of the pipe industry has been the successful use of steel in the manufacture of wrought pipe. This innovation by one of the leading pipe mills in the early '80's, met with a storm of opposition, not only from rival mills, but from engineers as well.

"It was represented that a perfect weld could not be made with steel; that steel pipe could not be threaded, and that it was even more unreliable and treacherous when under pressure than cast-iron pipe. As late as ten years ago, many engineers refused to accept steel pipe as a substitute for wrought-iron pipe, although manufacturers were prepared then, as now, to prove its superiority. Since then engineers have so universally adapted themselves to the new conditions, that when an occasional nonconformist specifies wrought-iron pipe, in preference to steel, it is assumed that he has not kept pace with the wonderful progress that has been made in the manufacture of steel tubular goods during the last decade. At the present time manufacturers are producing a uniform quality of steel for pipes, that for malleability, ductility, and weldability, cannot be excelled by the more expensive product of the puddling furnace, while for tensile strength it is vastly superior to the highest grades of iron."

So far as the strength and the resistance of steel pipe to corrosion are concerned, Mr. Riffle refers to the experiments of Dr. H. M. Howe, which show the strength of the steel pipe to exceed that of wrought-iron pipe by amounts varying from 41 to 119 per cent., while so far as corrosion goes the tests made by Dr. Howe show that there is no appreciable difference between steel and wrought iron.

Mr. Riffle still further adopts the position of the manufacturers when he advises the user to leave the question of specification to the maker, either accepting the product without limitations, or selecting from among the maker's specifications that which most nearly meets his requirements. Thus he says:

"Engineers sometimes prepare elaborate specifications for pipe without stopping to consider if they are practicable. So far as the quality of the material and the details of manufacture are concerned, it is always advisable to conform to the practice of the best pipe mills. All grades of steel, for example, are not equally weldable, therefore it would be a waste of time to specify steel that could not be welded. It is always a good plan to obtain from some reputable mill such specifications as are best adapted to the work in hand. Arrangement can then be made to have the pipe made in accordance with these specifications under the supervision of a competent inspector."

All this is eminently satisfactory, if the manufacturer may be considered as such an

altruistic party as to select always the best for the customer; but Mr. Freeman evidently has views of his own upon this point. Thus, after stating that steel pipe is supplied in filling order for wrought iron material, and that the steel pipe runs from 5 to 15 per cent. under the weight of standard wrought iron pipe of the specified dimensions, he goes on to say that the quality of material used in steel pipe is not of standard quality, but is skelp made of steelworks scrap, possessing none of the ordinary excellent qualities of mild steel as found in boiler plates and structural shapes. Under such circumstances Mr. Freeman suggests that further information is desirable upon the relative merits of iron and steel pipe, upon the relative strengths of existing pipe, upon the relative chemical composition of the material in steel pipe and that in structural steel and boiler plate, and upon the safe working strength of commercial pipe and fittings.

Accepting Mr. Freeman's position to the extent that it is most desirable that the truth in the matter be made public and that definite information concerning the vital points suggested be obtained, it may well be considered whether steel is not as superior to iron for pipe as it has been found superior to iron for other purposes. If the manufacturers put as good steel into pipe as they do into other products, and if every care is taken to insure toughness, perfect welds and general uniformity, there appears to be no good reason why steel should not be used, and many reasons why it should be favored.

At one time wrought iron rails were the rule, and steel rails the exception, but that day has long since passed, and wrought iron is no longer in the market for rails. The same transformation may be desirable for pipe, but the pipe must be proportionately as good as the rails, or the change cannot be expected to meet the approval of that careful and reliable class of engineers so well represented by Mr. Freeman.

ELECTROLYTIC COPPER REFINING.

EXPERIMENTAL DETERMINATION OF DATA OF COSTS AND OF ECONOMICAL OPERATIVE CONDITIONS.

W. D. Bancroft—American Electrochemical Society.

AMONG the papers presented at the recent meeting of the American Electrochemical Society at Niagara Falls was one by Mr. Wilder D. Bancroft, discussing the costs of the various operations involved in the electrolytic refining of copper, these results having been especially determined by experiments made for the purpose. In view of the value of the data we give some abstract of the paper, referring the reader to the original for the details.

"In determining the best conditions for the electrolytic refining of copper, we must consider the cost of the power necessary to precipitate a tank-full of copper under different current densities and at different temperatures; the cost of heating the tank; the deterioration of the electrolyte; the interest charge on the copper in the tank; the cost of pumping, and the quality of the copper deposited. Good adherent copper can be obtained at almost any current density, provided the rate of circulation be sufficient. The question of the cost of pumping has not been taken up, and is supposed to remain constant while the conditions are varied. The watt-hours necessary to precipitate a gramme of copper increase with increasing current density, and decrease with rising temperature. The cost of heating increases with rising temperature, and the interest charge on the copper in the tank decreases with increasing current density. With increasing current density, we have to strike a balance between the increasing power and the decreasing interest charge. With rising temperature, we have to strike a balance between the decreasing cost of power and the increasing cost of heating."

Tests were made to determine the variation of voltage with variations of temperature, current density, and solution, the standard solutions being used and also the effect of the addition of sodium chloride. In this way information was obtained as to the variations of current efficiency when operating with different electrolytic solutions at varying temperatures and different cur-

rent densities, there being differences of opinion upon some of these points. The general opinion has been that current efficiency falls off rapidly when the temperature rises above 50° C., but the tests showed that the efficiencies diminished very little for temperatures below 70° C., and that even at a temperature of 90° C. the efficiency was more than 90 per cent.

The presence of iron in the electrolyte has been assumed to lower the current efficiency, but this was wholly disproved by the tests, and no iron was precipitated from the solution.

Since the temperature is an important element in the cost of the work a series of experiments were made to determine the cost of maintaining the electrolyte in the vat at the operating temperature. Experiments were made with a tank which could be heated by a platinum coil, and the losses at various working temperatures were measured. It was found that a material saving was made by covering the vat, and a table is given showing the losses both for covered and uncovered vats from which the effect in operation may be described.

It is evident that to operate at a temperature of 90° and a low-current density is entirely out of the question, not only on account of the cost of power to heat the solution and precipitate the copper, but also on account of the deterioration of solution, which takes place very rapidly under these conditions. At this high temperature and the higher current densities, the cost rapidly approaches a minimum, but here also the deterioration probably more than offsets the advantage of reduced cost of power. To operate at 20° C. is not so costly as would seem at first thought. The cost is maximum at the lowest and the highest current densities, reaching a minimum between two and one-quarter and two and one-half amp/qdm.

The conclusion is that the best result would be obtained at a temperature of 70°, with a current density between 3.5 and 3.75 amp/qdm, since at this density no extra power is required to heat the solution. Operating at this current density, and with the tanks covered, the current alone would be able to heat the electrolyte to over 80° C. In order to secure a good circulation, essential for a good deposit with high current density, the present method of pumping should be retained.

The lower the cost of heating, the greater the advantage of a high temperature. Lowering the rate of interest decreases the advantage of a high-current density. With covered tanks, it will be possible for men to work in the tank room even with the electrolyte at 70°.

If we compare the cost of working under so-called standard conditions of open tanks, a current density of fourteen amp/sq ft and a temperature of 50° with the cost of working with covered tanks at 70° and a current density of 3.5 amp/qdm (31.5 amp/sq ft), the saving by the latter method will be very close to a dollar a ton of refined copper when all power is figured at $20 per horse-power-year.

Therefore, in order to operate a plant most economically, copper should be refined electrolytically under these conditions:

1. Covered tanks.
2. Current density 3.5 amp/qdm.
3. Temperature 70°.

ELECTRIC AND STEAM TRACTION.

THE PROFITABLE RESULT OF THE INTRODUCTION OF ELECTRIC POWER ON THE MANHATTAN ELEVATED RAILROAD.

Electrical Review.

THE advantages of electric traction for surface tramways have been so fully demonstrated as to need no comment at this late date, but the relative economy of electricity and steam has, until recently, been rather a matter for deduction than certainty. The published results of the workings of the elevated railways in New York since their conversion from steam to electric driving, however, give definite figures upon which some very interesting comments are made in a recent issue of the *Electrical Review*.

For many years the Manhattan Elevated Railway had been successfully operated by steam locomotives. It carried its passengers

with a certain degree of comfort and speed, handling numbers greater than any other similar corporation previously, and at the same time earned dividends for its stockholders. Ever since the development of electric transportation, projects and suggestions have been made to change the Manhattan from steam locomotives to electric distribution. A conservative management, backed up by reasonably satisfied and cautious stockholders, deferred the improvement until such time as the demands of the traffic exceeded the capacity of the plant when operated by steam locomotives.

Without giving the full tabulation of the comparative earnings of the elevated railroads in Manhattan for the quarter ending on June 30, 1903, and the corresponding quarter of the previous year, the following facts will suffice to show the advantage of the change from steam to electricity. The gross earnings during the three months showed an increase of $400,000, while the expenses were reduced $99,000, there being thus shown a gain to the profit account of about half a million dollars. The cost of carrying a passenger in 1902 is given as 2.24 cents, while with the electric traction this has been reduced to 1.98 cents.

The important consequence of all this appears in the substantial object lesson which has been given to the men who control steam traction on the great main-line railways. As is pointed out in the article referred to, the men who are interested in the elevated railway system in New York are also the individuals who control the destinies of the majority of the steam railroads of the United States. These men have naturally hesitated to consider anything leading to the conversion of the railways in which they are interested on the principle of let well enough alone. With the example of what has been done on the elevated railroad, however, they need not look to outside sources of information, but have the data entirely in their own hands.

The data furnished by the elevated railroads of New York, however, will need careful examination and digesting before the results can be made available for use in passing upon main-line service.

In the first place, the traffic is undoubtedly more intense on the Manhattan railway than on any other line in the world, so that there is the business upon which the difference can be shown. The entire length of the system is equal to about 100 miles of single track, while over this length of road about 800,000 passengers are carried daily. To draw conclusions from information derived from such conditions for application to systems over which a fraction of the business is done is liable to be misleading in the extreme.

At the same time, there is some indication of the possible transformation which such information may indicate in the conduct of main-line transport. The electrification of steam railways will undoubtedly begin with the local and suburban branches, and on these the density of traffic is sufficient to make a good showing. With increased speeds, such as have already been shown to be possible on the Berlin-Zossen military road, the range of local traffic will be extended, and what was formerly trunk-line business will find itself being conducted upon local methods, with continuous service of frequent small trains at close time-intervals, instead of the time-table method now in vogue. This alone will tend to increase the business, on the time-honored principle that facilities create traffic, and the suburbs of the great cities will be determined on a time basis instead of distance.

The requirements of municipal cleanliness and safety will soon compel all steam railways to use electric traction for their entrance to terminal stations, and the service of electric locomotives for such service will doubtless gradually extend out to near-by points, but with constantly increasing distances as the advantages make themselves apparent. It must be remembered that what were once the beginnings of the great trunk railway systems are now but their local sections, and the growth of electric traction as a substitute for steam locomotives may well follow the same method of development. The steam engines need not be scrapped until they meet their end in the natural order of things, but in the meantime the methods of replacement will have had time to become modified, so that the question of cost can be permitted to take care of itself. In the meantime the work of the example in New York will go on, and information as to the money-making capacity of electric traction be demonstrated.

THE ELECTRICAL SMELTING OF COPPER.

RESULTS OBTAINED WITH THE KELLER AND LELEUX FURNACE AT GRENOBLE IN THE DIRECT SMELTING OF COPPER BY ELECTRICITY.

Société des Ingénieurs Civils de France.

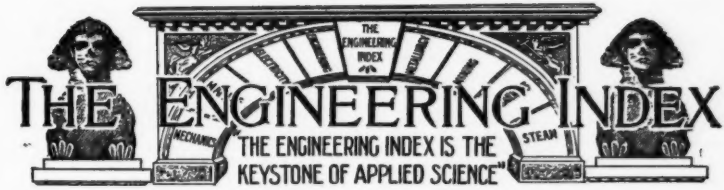
IN spite of the difficulties as regards cost compared with the use of ordinary fuels, engineers continue to make determined efforts to employ the electric current for the smelting of metals from their ores, and we have already chronicled in the columns a number of the plans which have been proposed and tried. Some of these efforts appear to give promise of practical success, and in a paper recently presented before the Société des Ingénieurs Civils de France, and published in the *Mémoires* of the society, M. Ch. Vattier gives an account of the work which has been done at Grenoble with the Keller and Leleux furnace for the electrical smelting of copper.

M. Vattier relates how, in the course of a visit to Chili, he brought to France a quantity of ores of copper, iron, and manganese for purposes of experiment, and after some preliminary trials at the works at La Praz, he made a careful trial with the furnace at Livet, near Grenoble. The result of these trials was so encouraging that proper modifications in the furnaces were made and plans for the further reduction of copper ores by electricity were arranged.

M. Vattier gives in his paper a report of a test made in the presence of a number of eminent English and French metallurgists, showing that 8,000 kilogrammes, or 8 metric tons, of ore were treated in the electric furnace and fully reduced to a matte in eight hours by the expenditure of 500 kilowatts of electrical energy. This ore contained about 7 per cent. of metallic copper, and the resulting matte showed 43 per cent. of metallic copper, while but 0.1 per cent. of metallic copper was found in the slag. The consumption of the carbon electrodes during the operation amounted to 6 to 7 kilogrammes per ton of ore treated, but by the use of electrodes of artificial graphite this consumption may be reduced to 5 kilogrammes per ton.

The furnace used is of a double type, there being an upper crucible in which the ore is fused in the arc formed between two electrodes, and a lower portion into which the fused material flows, this latter being provided with movable carbon electrodes which may be plunged into the molten bath or raised above the surface. By this arrangement the fusion is fully effected in the first crucible and the reduction finally effected in the second portion, the latter operation being capable of close regulation, the slag being drawn off above and the fused matte by separate openings lower down. The result of numerous experiments with this apparatus have shown that 100 tons of ore can be treated in 24 hours by the expenditure of 3,000 horse power, so that the cost of the operation may be determined by the cost of power in the locality where the work is done.

M. Vattier goes somewhat into detail into the matter of the cost of smelting the same ores in Chili, and shows that the question of the economical employment of electric energy for smelting over the use of coke furnaces is worthy of consideration in that locality. Thus, at the foot of the Cordilleras, where the "Volcan" mine from which the ores above referred to were taken, coke costs at least 100 francs per metric ton, while ample and uniform hydraulic power is readily and cheaply obtainable. The coke furnaces there in use consume 3,200 kilogrammes of coke per ton of copper produced in the form of matte, so that there is a cost of 320 francs per ton on the fuel account. The cost of electrical energy is estimated by M. Vattier as 30 francs per kilowatt year, or at 1.25 kilowatt per ton of copper produced, gives 38 francs for the cost of the current. The cost of electrodes is put at 45 francs, or a total of 83 francs as against 320 francs for the older process, all other charges being assumed to remain unchanged. The advantages of electrical smelting appear, but in a lesser degree, for poorer ores, and in any case the cost should be worked out according to the quantity of ore to be treated and the local conditions under which the work is done.



The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

Concrete-Arch.

The 80-ft. Concrete-Arch Bridge Over the San Leandro Creek, San Leandro, Cal. William B. Barber. Illustrated description of a monolithic structure built entirely of concrete. No iron was used in the construction of any of the parts. 600 w. Eng News—Aug. 27, 1903. No. 57641.

Hinged Arch.

The Graphical Computations of Triple-Hinged Arch Bridge (Le Calcul Graphique des Ponts en Arc). M. Jacquier. A study of the distribution of forces in arches with hinges at the crown and springings, employing the method of lines of influence. 5000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre—1903. No. 58044 E + F.

Loadings.

Loadings for Railroad Bridges. An informal discussion of the subject—"In view of the increasing weights of rolling stock, for what loadings should railroad bridges be designed?" 2400 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57688 E.

Loadings for Railroad Bridges. Continued discussion. 800 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58111 E.

We supply copies of these articles. See page 315.

Long Span.

Connel Ferry Railway Bridge. Illustrated detailed description of a bridge in Scotland, which has the second longest clear-span in Europe. 3300 w. Engr, Lond—Sept. 11, 1903. No. 57914 A.

Mississippi.

The Mississippi River Bridges. F. B. Maltby. An illustrated historical and descriptive sketch. 32000 w. Jour W Soc of Engrs—Aug., 1903. No. 57980 D.

New York.

Blackwell's Island Bridge. Perspective view of the bridge as it will appear when completed, with brief description and general information. 1000 w. Sci Am—Sept. 19, 1903. No. 57890.

The Blackwell's Island Bridge. Specifications for the material and workmanship for the superstructure, and engravings showing the plan and elevation of this bridge, with details. 1400 w. R R Gaz—Aug. 28, 1903. No. 57639.

Reconstruction.

The Reconstruction of the Frans Bridge (La Reconstruction du Pont de Frans). G. Canat. An account of the replacement of the suspension bridge over the Saone at Villefranche by a cantilever railway bridge. 6000 w. 2 plates. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58046 E + F.

Reinforced Concrete.

Foot Bridge in Reinforced Concrete (Passerelle en Béton Armé). Col. G. Espitallier. Illustrated description of a bridge of 42 metres span on the Hennebique system over the Canal du Midi, at Toulouse. 1800 w. Génie Civil—Sept. 5, 1903. No. 58007 D.

Suspension.

Repairing the Williamsburg Bridge Cables. An illustrated article describing the very efficient repairs made to the cables injured by fire on this East River bridge at New York. 1200 w. Eng Rec—Sept. 5, 1903. No. 57789.

Swing Bridge.

New Swing Bridge Over the Amsterdam Canal. Gives an outline elevation and description of a new swing bridge, of very considerable span, at Velzen, Holland. 1000 w. Engr, Lond—Sept. 18, 1903. No. 58107 A.

Transporter Bridge.

A Great Ferry Bridge. Brief notes on bridges of this description at Martrou, and at Nantes, with illustrated description of one to be erected at Bordeaux, with a span of a quarter of a mile in length. 2000 w. Engr, Lond—Aug. 28, 1903. No. 57722 A.

Widnes and Runcorn Transporter Bridge. Illustrated description of this bridge and its operation. 2200 w. Prac Engr—Aug. 21, 1903. No. 57570 A.

Viaduct.

Erection of the Atlantic Avenue Improvement Viaduct, Brooklyn. An illustrated article describing the erection of about 13,600 ft. of steel viaduct to carry the Long Island R. R. 2700 w. Eng Rec—Sept. 5, 1903. No. 57788.

The Viaur Railway Bridge. J. Walter Pearse. Gives the history of the bridge, the general conditions, and an illustrated description of the structure and its erection. 6300 w. Fielden's Mag—Sept., 1903. No. 57966 B.

The Viaur Viaduct on the Railway Line from Carmaux to Rodez, France. M. René Bonnin. Illustrated detailed description of the work, with discussion of the principles and advantages of the design. 8500 w. Eng News—Sept. 10, 1903. No. 57821.

Weighbridge.

Combined Weighbridge for Weighing Mixed Trains. Brief illustrated description of weighbridges recently introduced for railway service at Birmingham, Eng. 500 w. Engng—Sept. 11, 1903. No. 57910 A.

Yellowstone Park.

Bridge Work in the Yellowstone Park. An illustrated article describing work carried on by the U. S. government. The work of placing concrete is carried on day and night without permitting the material to set before deposits are added. 1300 w. Ry & Engng Rev—Sept. 5, 1903. No. 57755.

CANALS, RIVERS AND HARBORS.

Back Water.

A New Method of Computing the Backwater Curve (Ein Neue Weg zur Berechnung der Staukurve). Dr. A. Fliegner. Developing equations enabling the curve to be computed for any relative fall. 2000 w. Schwerzerische Bauzeitung—Aug. 22, 1903. No. 58080 B.

Bavaria.

The Danube--Main Canal System (Die Donau-Main-Wasserstrasse). D. Lange. A review of the proposed development of the canal system of Bavaria. 2500 w. Glasers Annalen—Sept. 1, 1903. No. 58024 D.

Dams.

A Severe Flood Test of an Earth Dam at Newcastle, Pa. G. B. Zahniser. Illustrates this dam and describes its construction and the severe test due to an unusual storm. 800 w. Eng News—Sept. 24, 1903. No. 57956.

We supply copies of these articles. See page 315.

The Borings for the Bohio Dam for the Panama Canal. R. C. Smith. An illustrated article giving a brief description of the method of making these borings, the difficulties encountered, and the results obtained. Also discussion. 8000 w. Jour W Soc of Engrs—Aug., 1903. No. 57-978 D.

Docks.

Dock Improvements at Liverpool. George Cecil Kenyon. Illustrates and describes works in progress in connection with the construction of new deep-water entrances at Brunswick dock. 11200 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58110 E.

The New Graving Dock of the Kawasaki Dock Yard Co. at Kóbe, Japan. Dr. Genjiro Yamasaki. An illustrated detailed description. 4500 w. Eng News—Sept. 24, 1903. No. 57955.

Dredge.

Bucket and Suction Dredge (Drague Marine Porteuse et à Refoulement). Ch. Dantin. Illustrated description of a seagoing dredge built for Tunis by Smulders of Rotterdam. 1500 w. 1 plate. Génie Civil—Aug. 29, 1903. No. 58004 D.

The Chaquette Pneumatic Dredge. An illustrated description of a power-clamshell dredge, invented by Ehraiem Chaquette. 1000 w. R R Gaz—Sept. 11, 1903. No. 57827.

Floods.

Engineering Aspects of the Kansas Floods. Waddell & Hedrick. Brief outline of the damage with short descriptions of the bridges destroyed,—17 in all. Ill. 2400 w. Eng Rec—Sept. 12, 1903. No. 57880.

The Kansas City Flood of 1903. An illustrated description of the great flood, the damage done, etc. 2500 w. Eng News—Sept. 17, 1903. No. 57943.

Flow.

Methods of Measuring Velocity in River Channels. H. A. Pressey. Abstract from a monograph entitled "Observations on the Flow of Rivers," published by the U. S. Geol. Surv. Illustrates and describes methods of stream measurement. 3500 w. Sci Am Sup—Sept. 5, 1903. No. 57774.

Isthmian Canal.

Panama or Nicaragua? Editorial discussion of the attitude of the Columbian legislators, and of some of the advantages of the Nicaragua route. 2000 w. Eng News—Sept. 17, 1903. No. 57945.

The Republic of Colombia and the Panama Canal. John George Leigh. A handsomely illustrated account of the industrial and political conditions in the mainland state, showing the general character of the country as a whole. 4000 w. Engineering Magazine—Oct., 1903. No. 58081 B.

Levees.

The Levee Theory on the Mississippi River. An informal discussion of the subject—"In the treatment of the Mississippi River, is the levee theory justified by experience?" 21000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57689 E.

Light-houses.

Revolving Lanterns for Light-houses. Illustrates and describes three types of flashing lanterns, with remarks on the difficulty in making and properly mounting the lenses. 900 w. Sci Am—Sept. 26, 1903. No. 57958.

Navigation.

The Elements Constituting a Navigable Waterway (Des Elements Constitutifs d'une Voie Navigable). MM. Cadart et Barbet. A discussion of the relation of capacity to the frequency of travel upon canals and other internal waterways. 8000 w. 1 plate. Ann des Ponts et Chaussées —1 Trimestre, 1903. No. 58043 E + F.

The Ninth International Navigation Congress (IX Congrès International de Navigation). Report of the French Delegates to the congress held at Düsseldorf in 1902., with the general reports upon the various questions submitted to the congress. 40000 w. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58042 E + F.

CONSTRUCTION.

Beams.

Deflections of Beams with Variable Moments of Inertia. Discussion of paper on this subject by C. W. Hudson, continued from May, 1903. 3800 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57685 E.

The Flexure of Beams. An account of experiments given in a recent work by Albert E. Guy. 3500 w. Builder—Aug. 29, 1903. No. 57701 A.

Building Construction.

Structural Steel Work in the Macy Building, New York City. Illustrated detailed description of the framework of a recently built department store having nine stories, a basement and sub-basement. 2200 w. Eng Rec—Sept. 19, 1903. No. 57934.

Caissons.

Auxiliary Pneumatic Caisson Work for the Bank of the State of New York. An illustrated description of difficult foundation work in New York city, where the soil was sandy and very wet. After a large amount of work had been done on the building, the excavation was carried down 10 ft. farther. 2500 w. Eng Rec—Aug. 29, 1903. No. 57635.

We supply copies of these articles. See page 315.

Iron Framing.

Early Iron Building Construction. Illustrates and describes interesting details of floor framing in an old building in New York. 2700 w. Eng News—Sept. 10, 1903. No. 57820.

Retaining Walls.

Mistaken Ideas with Reference to the Resultant Force and the Maximum Pressure in Retaining Wall Calculations. J. S. D. Moffet. An explanatory illustration. 1300 w. Feilden's Mag—Sept., 1903. No. 57965 B.

Use of Mineral Oil in Road Improvement. James W. Abbott. From the year book of the U. S. Dept. of Agri. for 1902. A review of tests, benefits, objections, preparation, etc. Ill. 6800 w. Automobile—Sept. 5, 1903. No. 57742.

Roads.

Methods of Macadam Construction in Some New Jersey Towns. Describes the method used in northeastern New Jersey, discussing its merits. 1500 w. Eng News—Aug. 27, 1903. No. 57644.

Roofs.

Notes on Roofs and Roof Coverings. Especially considers suitable material for the roofs of mining and metallurgical works. 2000 w. Eng & Min Jour—Sept. 5, 1903. No. 57786.

Tunnels.

A New Tunnel at Genoa. An illustrated article describing interesting details of working adopted by reason of the difficult conditions under which the operations had to be carried out. 2400 w. Engr, Lond—Aug. 28, 1903. No. 57723 A.

The Simplon Tunnel (Simplon-Tunnel). The Nineteenth quarterly report, showing the progress made from April 1 to June 30, 1903. There is now about 77 per cent. of the total length completed. 2000 w. Schweizerische Bauzeitung—Aug. 15, 1903. No. 58079 B.

MATERIALS.

Cement.

Portland Cement Manufacture. Edwin C. Eckel. The present article deals with the preparation of dry materials for the kiln. 1500 w. Munic Engng—Sept., 1903. No. 57985 C.

Progress Report of Special Committee on Uniform Tests of Cement. Discussion of this report, by Sanford E. Thompson. 1700 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57686 E.

The Fatigue of Cement Products. J. L. Van Ornum. States results of experiments made to determine the behavior of certain Portland cement mixtures when subjected to repeated loads of a less intensity than would produce failure when once applied. 700 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57684 E.

Concrete.

Impervious Concrete. An informal discussion of the subject—"Is it possible to make concrete which will be impervious to water? If so, what is the best method?" 7000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57690 E.

The Uses of Concrete in Recent Engineering Practice. Samuel H. Lea. Read before the Scranton Engineers' Club. Considers the materials from which it is made and the purpose to which it has been applied. 4800 w. Mines & Min—Sept., 1903. No. 57596 C.

Concrete Mixing.

The Efficiency of Concrete Mixing Machines. Clarence Coleman. Reports investigations made to determine the comparative efficiency of these machines. Ill. 3200 w. Eng News—Aug. 27, 1903. No. 57646.

Explosives.

High Explosives; Safe and Economical Methods of Handling. J. H. Karkeet. Condensed paper, read before the L. Sup. Min. Inst. Notes the progress made in the manufacture and use of these explosives, their advantages, methods of handling, etc. 2500 w. Eng & Min Jour—Sept. 19, 1903. No. 57942.

Lime.

The Manufacture and Properties of Hydrate of Lime. S. Y. Brigham. Describes the method of manufacture, showing the results of comparative tests, and making a general comparison with the qualities of quick lime in the lump form. 1600 w. Eng News—Aug. 27, 1903. No. 57642.

Paints.

The Value of White Paints on Engineering Structures. Explains why white paint is not a permanent paint, both from a chemical and physical point of view. Considers also attempts that have been made to produce a permanent white lead pigment. 3500 w. Engr, Lond—Sept. 4, 1903. No. 57858 A.

Reinforced Concrete.

Test of a Reinforced Concrete Slab. Sanford E. Thompson. Describes a test made by the writer. 600 w. Eng Rec—Sept. 12, 1903. No. 57883.

Sand Cement.

Sand-Cement and Sand-Lime Brick. Paul. Tafel. Gives the early history of the industry. Considers it adapted to all kinds of building purposes. 1200 w. Munic Jour & Engr—Sept., 1903. Serial. 1st part. No. 57751 C.

We supply copies of these articles. See page 315.

Timber.

Timber Tests. An informal discussion. 18500 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57687 E.

MEASUREMENT.

Surveying.

The Standard and Its Use in Surveying. Edward Riordan. Illustrated description, with remarks on its various uses. 1200 w. Eng News—Aug. 27, 1903. No. 57645.

MUNICIPAL.

Fire Prevention.

Fire Patrol Service for Dock Property. W. H. Hunter. Read before the International Fire-Prevention Congress. An account of the system of fire-preventive methods in operation at the docks of the Manchester Ship Canal. 4500 w. Engng—Aug. 21, 1903. No. 57583 A.

Pavements.

Brick Pavements. George W. Tillson. First of a series of four articles. Describes their origin and qualities, imperviousness to moisture, etc. 2800 w. Munic Jour & Engr—Sept., 1903. Serial, 1st part. No. 57749 C.

Wood Pavement in Greater New York. F. A. Kummer. An illustrated article describing methods of laying. 1500 w. Munic Jour & Engr—Sept., 1903. No. 57750 C.

Sewage.

On the Distributing of sewage on Bacteria Beds. John C. Thresh. Read before the Sanitary Inst. Discusses briefly the three methods in use, favoring distribution by sprinklers or sprays, at frequent intervals. 2000 w. Engng—Aug. 21, 1903. No. 57584 A.

Sewage Purification. Informal discussion by Messrs. Rudolph Hering and George W. Rafter. 3400 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58113 E.

Sewage Pumps.

Sewage Pumping Plant. Illustrated description of a triple-expansion, vertical sewage pumping engine, built for the Melbourne and Metropolitan Board of Works. 1600 w. Engr, Lond—Aug. 21, 1903. No. 57587 A.

Sewers.

A Large Concrete-Steel Sewer. Brief illustrated description of the Cleveland intercepting sewer, being built of concrete reinforced with steel rods. 1000 w. Eng Rec—Aug. 29, 1903. No. 57636.

Infiltration of Ground Water into Sewers. J. N. Hazlehurst. Shows the desirability and the difficulty of securing better joints, that infiltration may be reduced. Gives report of X. H. Goodnough bearing on this subject. 2500 w. Eng News—Aug. 27, 1903. No. 57643.

WATER SUPPLY.

Depreciation.

Depreciation. John W. Alvord. Examines in detail some of the features of water-works plants, and the conditions under which they depreciate. 3000 w. Fire & Water—Aug. 29, 1903. Serial. 1st part. No. 57655.

Filtration.

A Mechanical Filter Plant for the Ithaca Water Works Company. A statement of the conditions to be met and the past history of the water supply, with an illustrated description of the filtration plant near completion. 3400 w. Eng Rec—Aug. 29, 1903. No. 57634.

Automatic Modules for Regulating the Speed of Filtration. Continued discussion of paper by Charles Anthony, Jr. 2800 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57691 E.

Filtration at Little Falls, N. J. An illustrated description of this new plant of the East Jersey Water Co., which successfully filters 32,000,000 gallons in twenty-four hours. 3000 w. Fire & Water—Sept. 12, 1903. No. 57866.

Filtration for Public Water Supplies, with Especial Reference to the Double Filtration Plant at Bremen, Germany. Eugen Goetze. An illustrated description of some of the characteristic features of the Bremen filter works. 5000 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58109 E.

Lawrence Filter Division Walls. An illustrated description of the filter bed division walls at Lawrence, Mass. 1800 w. Fire & Water—Aug. 29, 1903. No. 57654.

The Sterilization and Filtration of Potable Water (Sterilisation et Filtration des Eaux d' Alimentatión). F. Gramyr. An illustrated account of the Desrumeaux system of mechanical filtration, employing alum as a coagulant. 3000 w. 1 plate. Revue Technique—July 25. 1903. No. 58040 D.

Irrigation.

Ancient Chaldean Irrigation. An illustrated article describing the ancient irrigation works of Chaldea, with a suggestion for their restoration. 3700 w. Builder—Sept. 19, 1903. No. 57986 A.

South African Irrigation. Francis Robert Johnson. An account of the use thus far made of irrigation, the methods and description of typical colonial furrows, as they are called. Also information of the geology, rainfall, water supply, crops, and related matters of interest. 8000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57682 E.

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Reservoirs.

Reservoir Repairs at St. John, N. B. An illustrated description of the improvement of source of supply, increasing the reservoir capacity, and connected work. 1800 w. Fire & Water—Aug. 29, 1903. No. 57653.

Supplies.

Water Supply. Charles Hawkesley. From the presidential address to the Engng. Soc. of the British Assn. Considers the main features of water-works construction and management. 7000 w. Archt, Lond—Sept. 18, 1903. No. 57998 A.

Underground Supply.

The Geology and Underground Water Suply of South Lincolnshire. Henry Preston. Abstract of a paper read before the British Assn. of W-Wks. Engrs., with a summary of the discussion. Observations on wells and borings made and the relationship to their geological causes. 6000 w. Jour Gas Lgt—Sept. 15, 1903. No. 57906 A.

Water Waste.

Further Results of the Water Waste Investigations in New York City. A reprint of the third report, giving interesting results. 2400 w. Eng Rec—Sept. 19, 1903. No. 57936.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic-System.

The Strowger Automatic Telephone System (Das Selbstanschluss System für Fernsprechämter von Strowger). H. Feyerabend. A fully illustrated description of the American automatic telephone system of Strowger, now being introduced into the German Post Office. 7000 w. Elektrotech Zeitschr—Sept. 3, 1903. No. 58066 B.

Cables.

Telephone Cables with Iron Wire Wrapping (Ueber Fernsprech Kabel mit Eisendrahtumwickelung). C. E. Walsöe. A discussion of the inductive effect of external iron wire wrapping upon telephone cables. 1800 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58070 B.

Two Simple Methods for Locating Faults in Cables. Edwin E. Northrup. Describes two methods of locating faults occurring on telephone lines. 1600 w. Elec Rev, N Y—Aug. 29, 1903. No. 57600.

Great Britain.

Government Telegraphs and Telephones in Great Britain. Calls attention to interesting statistics appearing in the last report of the British Postmaster-General. 1600 w. Elec Wld & Engr—Sept. 12, 1903. Serial. 1st part. No. 57884.

Pupin System.

Experiments upon the Pupin System of Long Distance Telephony (Untersuchungen über Telephonische Fernleitungen Pupinschen Systems). A review of the Siemens & Halske experiments upon the Pupin inductance coils in Germany. 2000 w. Glasers Annalen—Aug. 15, 1903. No. 58022 D.

Space Telegraphy.

Communication with Trains by Wireless Telegraphy. Describes the Guarini-Caesar system, which employs existing lines of telegraph wires. Ill. 1000 w. Sci Am—Sept. 26, 1903. No. 57960.

De Forest Wireless Telegraph on the Steam Yacht Erin. Illustrated detailed description of the installation and report of its working. 2000 w. Marine Engng—Sept., 1903. No. 57608 C.

Fessenden's Work in Wireless Telegraphy. A. Frederick Collins. Reviews Prof. Fessenden's work, noting the fundamental differences from other systems, and illustrating and describing some of the devices used. 2800 w. Elec Wld & Engr—Sept. 19, 1903. No. 57931.

Guarini's Wireless Fire Alarm Apparatus. Brief illustrated description of a device recently experimented with at Brussels. 600 w. Sci Am—Sept. 5, 1903. No. 57770.

Telegraphing by Electric Rays (La Télégraphie par Rayons Electriques). D. R. Blochmann. Describing experiments made with dielectric lenses for concentrating and directing the magnetic waves for space telegraphy. 1200 w. Rev Gendes Sciences—Aug. 15, 1903. No. 58050 D.

The Earth as a Condenser and Its Role in Wireless Telegraphy. Reviews a recent article in Dingler's *Polytechnische Journal* setting forth the views of Dr. A. Koepsel. 1800 w. Elec Wld & Engr—Aug. 29, 1903. No. 57604.

Telephone Station.

The New Telephone Station in Mannheim (Das Neue Fernprechamt in Mannheim). L. Dankwardt. A general description of one of the most recent telephone central stations in Germany, with details of the wiring and operation. 4500 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58069 B.

We supply copies of these articles. See page 315.

Telephony.

Some Features of Telephone Traffic and Their Effect on Service. J. G. Wray. 2800 w. Trans Am Inst of Elec Engrs—June and July, 1903. No. 57694 D.

DISTRIBUTION.

Conductors.

The Use of Aluminium as an Electrical Conductor. John B. C. Kershaw. Read before the British Assn. A record of experimental observations to ascertain the resistance to corrosion offered by commercial aluminium rod and wire. 2000 w. Elec Rev, Lond—Sept. 18, 1903. No. 57994 A.

Joints.

Electric Welded Joints. William Pestell. An illustrated article describing the work as carried out by the Johnson Co. and their successor. 2800 w. St Ry Rev (Daily Ed)—Sept. 5, 1903. No. 57807 C.

Rotary Converters.

Operation of Rotary Converters. W. T. Fernandez. Considers the operation and control of rotary converters operating in their natural capacity. Ill. 2200 w. Am Elect'n—Sept., 1903. No. 57780.

The Construction and Use of Rotary Converters in America (Bau und Betrieb von Drehumformern in Amerika). E. Alexanderson. With diagrams showing the practice of the General Electric Company. 2500 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58067 B.

Transformer.

A New Type of Transformer (Eine Neue Transformatorentype). E. Ziehl. Illustrated description of the Schwartzkopff transformer in which the core is arranged in a series of rectangles. 1200 w. Elektrotech Zeitschr—Sept. 10, 1903. No. 58068 B.

See also Street and Electric Railways.

ELECTRO-CHEMISTRY.

Acker Process.

The Acker Process for Alkali and Bleaching Powder by the Electrolysis of Fused Common Salt. Report of the Committee on Science and the Arts, of the Franklin Inst. Ill. 900 w. Jour Fr Inst—Sept., 1903. No. 57977 D.

Anodes.

Electrolysis at Smooth and Platinized Platinum Anodes. Prof. F. Foerster. Explains the difference in the behavior of smooth and platinized anodes at which no oxygen is evolved. 6500 w. Electro-Chem Ind—Sept., 1903. No. 57744 C.

Bleaching.

Electrolytic Production of Bleaching Liquor. W. H. Walker. Reviews the development of bleaching liquors, the apparatus used, and the systems that have had extensive trial. 3000 w. Electro-Chem Ind—Sept., 1903. No. 57740 C.

Electric Smelting.

Experiments in the Electric Smelting of Copper (Expériences Industrielles Electro-Metallurgiques pour la Fonte de Mineraio de Cuivre). Ch. Vattier. Describing experiments made on a large scale in smelting copper ores by the electric furnace at Livet, near Grenoble, with data as to costs. 5000 w. Mem Soc Ing Civ de France—July, 1903. No. 58026 G.

ELECTRO-PHYSICS.

Alternating Currents.

A Discussion of Some Points in Alternating Current Theory. W. S. Franklin. Discusses polar coördinate vs. clock-diagram method; necessity of choosing signs in complicated networks; etc. 4800 w. Trans Am Inst of Elec Engrs—June and July, 1903. No. 57693 D.

Electromagnets.

Powerful Electromagnets. Emile Guarini. An illustrated article showing the remarkable results obtained by M. De Mare. 700 w. Elect'n, Lond—Aug. 28, 1903. No. 57713 A.

Hysteresis.

Losses from Dielectric Hysteresis and the Capacity of High Pressure Machines (Ueber den Dielektrischen Hysteresisverlust und die Kapacität von Hochspannungsmaschinen). Dr. Paul Holitscher. An experimental investigation of the losses under high electric stresses in the micanite insulating tubes of motors and generators. 5000 w. Elektrotech Zeitschr—Aug. 13, 1903. No. 58055 B.

The Influence of the Distribution of Lines of Force in an Iron Ring upon the Losses by Hysteresis and Eddy Currents (Der Einfluss der Kraftlinienverteilung in einem Eisenringe auf die Verluste durch Hysteresis und Wirbelstrome). Rudolf Richter. A mathematical study of a general case, developing formulas and curves capable of application to generator and motor design. 4000 w. Elektrotech Zeitschr—Sept. 3, 1903. No. 58064 B.

Magnetism.

Terrestrial Magnetism in Its Relation to Geography. Capt. Ettrick W. Creak. Abstract of a presidential address to the Geog. Sec. of the British Assn. Reviews the work that has been done in the study of the earth's magnetism, and discusses magnetic changes, and work needing to be done in this field. 5400 w. Elect'n, Lond—Sept. 18, 1903. No. 57997 A.

Metals.

The Optical and Electrical Properties of Metals (Die Optischen und Elektrischen

Eigenschaften der Metalle). Dr. H. Rubens. A study of the relation of the optical and electrical properties of metals in connection with the reflection and absorption of luminous and Becquerel rays. 7500 w. Zeitschr d Ver Deutscher Ing—Sept. 12, 1903. No. 58018 D.

Radioactivity.

A Simple Method of Showing the Great Penetrating Powers of Certain Radium Rays. T. P. Black. An account of experimental investigations, with results. 900 w. Elect'n, Lond—Aug. 21, 1903. No. 57577 A.

Charles Vernon Boys Presidential Address to the Mathematical and Physical Section of the British Association. Outlines the properties of radium and points out the resemblance between radio-active phenomena and the origin and behavior of comets' tails. 8500 w. Engng—Sept. 18, 1903. No. 58105 A.

On Polonium and the Inducing Character of Radium. F. Giesel, in *Berichte d. Deutsch. Chem. Gesell.* An account of experimental investigations. 1000 w. Sci Am Sup—Aug. 29, 1903. No. 57616.

Radio-Activity and Chemistry. George F. Barker. An address delivered before the Chem. Soc. of Columbia Univ. An interesting review of investigations of radio-active substances, especially the recent work of Prof. and Madame Curie. Also the effects of the chemical action of these rays. Ill. 7500 w. Sch of Mines Qr—April, 1903. No. 57970 D.

The Radium Emanations. An editorial review of what has thus far been learned in regard to radium and like substances, and the investigations in progress. 3300 w. Engng—Aug. 28, 1903. No. 57727 A.

GENERATING STATIONS

Alternating Currents.

Some Effects of Armature Reaction in Alternating Current Machinery. W. M. Thornton. An acount of investigations, with diagrams. 2600 w. Elect'n, Lond—Sept. 4, 1903. No. 57844 A.

The Elementary Principles of Alternating Currents of Electricity. Prof. Tell. Aims to give a simple explanation. 2400 w. Engr, U S A—Sept. 15, 1903. Serial. 1st part. No. 57926 C.

The Production and Distribution of Alternating Current for Large City Systems. Richard McCulloch. Considers the production and transmission of alternating current, and the relative advantages of alternating and direct current transmission. Ill. 8800 w. St Ry Rev (Daily Ed)—Sept. 5, 1903. No. 57806 C.

The Parallel Working of Alternators. B. Hopkinson. Read before the British Assn. An attempt to co-ordinate the mathematical treatment of the subject with the practical rules which are now regarded as good practice, and to point out the reason for certain observed phenomena. 5000 w. Elect'n, Lond—Sept. 18, 1903. No. 57996 A.

Auxiliary Plant.

Comparison Between Steam and Electrically-Driven Auxiliary Plant in Central Stations. C. D. Taite and R. S. Downe. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. 2000 w. Elect'n, Lond—Aug. 21, 1903. No. 57580 A.

Breakdowns.

Breakdowns of Electrical Machinery. Michael Longridge. Abstract from the annual report giving particulars of the nature of breakdowns. Gives list of selected cases. 5700 w. Mech Engr—Sept. 19, 1903. No. 57991 A.

Continuous Current.

Some Notes on the Design of Magnet Systems for Continuous-Current Machines. Introductory notes to a discussion of the mechanical design of the magnet system are given in the present article. Ill. 1600 w. Elec Engr, Lond—Sept. 11, 1903. Serial. 1st part. No. 57900 A.

Dresden.

Combined Lighting and Heating Plant at Dresden. Illustrated description of an interesting installation having a common boiler plant for electricity supply and artificial heating by steam with long distance distribution. 2000 w. Elec Engr, Lond—Aug. 28, 1903. No. 57710 A.

Dynamo Design.

A Basis for the Comparison of Dynamo Designs. H. M. Hobart. Explains the suggested method. 1200 w. Elect'n, Lond—Sept. 11, 1903. No. 57903 A.

Notes on the Design of Continuous-Current Machines (Beitrag für den Entwurf von Gleischstrommaschinen). E. Dick. Developing equations for the computations of the proportions of parts, speed, weight, and other elements of continuous-current dynamos and motors. 2000 w. Zeitschr f Elektrotechnik—Aug. 16, 1903. No. 58076 D.

Hot-Water.

Hot-Water Heating in a Coal Country. Alton D. Adams. Illustrated description of the extensive system installed by the Miami Light, Heat and Power Co., of Piqua, O., for hot-water heating from an electric lighting station. 3300 w. Eng Rec—Sept. 19, 1903. No. 57933.

Hydro-Electric Stations.

Hudson River Water Power Co. Brief illustrated description of developments at Spier Falls, Mechanicsville and elsewhere

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on the Upper Hudson. 3500 w. St Ry Rev—Aug. 20, 1903. No. 57624 C.

Spier Falls Dam and Power Plant. Walter H. Main. Illustrations with brief description. 700 w. Sci Am—Sept. 12, 1903. No. 57816.

The Congress of the "Houille Blanche." Marcel Bloch. Deals briefly with the technical propositions and ideas set forth by this congress for the development of the hydraulic power from the melting snows of the French Alps. 2300 w. Elec Rev, Lond—Sept. 4, 1903. Serial. 1st part. No. 57841 A.

The Water Power Plant of the Columbia Mills Company, Columbia, S. C. An illustrated article considering the interesting features of this plant. 1500 w. Eng Rec—Aug. 29, 1903. No. 57633.

Ithaca, N. Y.

The Ithaca, N. Y., Electric System. An illustrated description of a very unusual system. 5300 w. Engr, U. S. A.—Sept. 15, 1903. No. 57924 C.

Railway Plant.

Power Plant of the Pittsburg, McKeesport and Connellsville Railway. Illustrated detailed description of a plant of 6,000 kilowatts capacity, built to operate a system of electric railways and furnish electric current for lighting and power. 4000 w. Eng Rec—Sept. 5, 1903. No. 57787.

Station Practice.

Electrical Station Practice. W. H. Radcliffe. The first of a series of articles aiming to prove of special value to dynamo tenders, station engineers, and all interested in the construction, equipment and management of these plants. 2000 w. Elec, N Y—Sept. 9, 1903. Serial. 1st part. No. 57792.

Storage Batteries.

The Practical Storage Battery Operation. H. P. Liversidge. Suggestions helpful in securing successful operation, showing that intelligent care is all that is needed. 5000 w. Am Elect'n—Sept., 1903. No. 57782.

Supply Works.

The Financial Improvement of Electricity Supply Works. Joseph A. Jeckell. Abstract of a paper before the Incor. Munic. Elec. Assn. Outlines the principles to be considered, showing how they were applied at Coventry, and the result. 4000 w. Elect'n, Lond—Aug. 21, 1903. No. 57581 A.

Switches.

The Evolution of the Starting Switch. Discusses the essential requirements of a satisfactory starting switch. 1600 w. Elec Engr, Lond—Sept. 4, 1903. No. 57840 A.

LIGHTING.

Nernst Lamp.

Light and Illumination. E. Leavenworth Elliott. An illustrated article explaining the principle and tracing the development of the Nernst lamp. 2500 w. Cent Sta—Sept., 1903. No. 57793.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

Angular Variation.

A New Method of Determining the Angular Variation of a Rotating System (Neue Methode zur Bestimmung der Winkelabweichung eines Rotierenden Systems). Joseph Sartori. A discussion of the angular variation of alternators operated in parallel, discussing the stroboscopic and other methods of measurement. 1800 w. Zeitschr f Elektrotechnik—Aug. 23, 1903. No. 58077 D.

Cables.

The Measurement of Cable Capacity. An extract from a chapter in Vol. II, of "A Handbook for the Electrical Laboratory and Testing Room," by Dr. J. A. Fleming. 2000 w. Elect'n, Lond—Sept. 11, 1903. No. 57904 A.

Meters.

Electric Meters. Caryl D. Haskins. Discussing their relation to the earning power of electric light companies. 2200 w. Cassier's Mag—Sept., 1903. No. 57938 B.

Motor Losses.

The Measurement and Separation of Losses in Nonsynchronous Polyphase Motors (Messung und Trennung der Verluste bei Asynchronen Drehstrommotoren). W. Peukert. Discussing experiments for measuring separately the hysteresis and friction losses in polyphase motors. 2000 w. Elektrotech Zeitschr—Aug. 20, 1903. No. 58058 B.

The Separation of the Friction Losses in Electrical Machines. Dr. Leo Fenzi. Translated from the *Elektrotechnische Zeitschrift*. Gives methods for determining the air friction and bearing friction. 800 w. Elec Engr, Lond—Aug. 28, 1903. No. 57711 A.

Ohm Meter.

A Direct Reading Ohm Meter (Ein Direkt Zeigendes Ohmmeter). Dr. H. Sack. An ampere meter is kept at zero by the current from a storage battery, and the introduction of the resistance to be measured causes a proportional deflection. 2500 w. Elektrotech Zeitschr—Aug. 20, 1903. No. 58059 B.

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Oscillograph.

A Simple Oscillograph (Ein Einfacher Oscillograph). A. Wehnelt. Describing a form of double magnet mirror galvanometer in which the oscillating deflections are proportional to the periodical variations of the current. The record is made on a moving band of photographic paper. 1200 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58062 B.

Speed Indicator.

The Dettmar Electric Speed Indicator. An illustrated description of an electric tachymeter for measuring the speed of vehicles that have a rectilinear motion, such as cars, automobiles, etc. 1400 w. Sci Am Sup—Sept. 12, 1903. No. 57819.

Power Measurement.

Measurement of Power in Alternating Current Circuits. Nathaniel R. Craighill. A description of the wattmeter method. 1500 w. Am Elect'n—Sept., 1903. No. 57781.

Measuring the Power of Machine Tools. George E. Walsh. A study of the power required by electrically driven machine tools. 1800 w. Am Elect'n—Sept., 1903. No. 57778.

Standards.

Explanations of the Standards for Classifying and Testing Electrical Machinery (Fläuterungen zu den Normalien für die Bewertung und Prüfung Elektrischer Maschinen und Transformatoren). G. Dettmar. A discussion of the standards of the *Verband Deutscher Elektrotechniker* for electric motors, generators and transformers. 1800 w. Elektrotech Zeitschr—Aug. 20, 1903. No. 58057 B.

Testing.

Shop Testing of Motors and Generators for Commercial Service. Bertrand B. Abry. Considers the usual shop tests as applied to new designs of direct and alternating current motors and generators. 1500 w. Elec Rev, N Y—Sept. 19, 1903. Serial. 1st part. No. 57928.

Voltmeters.

On the Use of Capacities as Multipliers in Connection with Electrostatic Voltmeters on Alternating-Current Circuits. Prof. E. W. Marchant and G. W. Worrall. Read before the British Assn. Describes experiments directed to the construction of a simple apparatus by which low-reading electrostatic voltmeters may be employed on circuits of much higher tension. 800 w. Elec Engr, Lond—Sept. 18, 1903. No. 57993 A.

Wattmeter.

The Electrostatic Wattmeter: Its Calibration and Adaptation for Polyphase Measurements. G. L. Addenbrooke. Explanatory notes on the use of this instrument. 2800 w. Elect'n Lond—Sept. 4, 1903. Serial. 1st part. No. 57843 A.

POWER APPLICATION.

Accumulators.

The Use of the Accumulator in Mining (Der Akkumulator im Bergbau). J. L. Huber. With illustrations of the extent to which the storage battery may be employed to equalize the load upon the generators in the supply of electrical energy for mining operations. 3000 w. Glückauf —Aug. 8, 1903. No. 58071 B.

Agriculture.

Electricity on the Farm. Emile Guarini. Illustrates and describes various agricultural machines worked by electricity. 1500 w. Elec Rev, Lond—Sept. 11, 1903. No. 57901 A.

The Present State of Electricity in Agriculture (Etat Actuel du Labourage Electrique). E. Guarini. A review of the applications of electric power to agricultural operations, with illustrations of ploughs, thrashing machines, trucks, etc. 2500 w. Génie Civil—Aug. 22, 1903. No. 58000 D.

Brake Magnets.

The Construction of Tubular Magnets for Brakes (Beitrag zur Konstruktion von Mantelmagneten für Bremszwecke). R. Hellmund. A discussion of the form and winding of tubular magnets for the construction of solenoid brakes. 4000 w. Elektrotech Zeitschr—Sept. 3, 1903. No. 58065 B.

Coal Cutting.

Electric Coal-Mining Plants. S. B. Belden. Shows the process by which they have been developed to meet the various requirements in different seams of coal. 3200 w. Mines & Min—Sept., 1903. No. 57592 C.

Electric Coal-Cutting. W. Walker. Abstract of a paper read at the Nottingham meeting of the Inst. of Min. Engrs. Gives experience with coal-cutting machinery in the hard coal at Digby Colliery and the New London collieries. Discussion. 2800 w. Col Guard—Sept. 18, 1903. Serial. 1st part. No. 57999 A.

Coal Handling.

Coal Handling Machinery Driven by Electric Motors. D. A. Willey. Illustrates and describes the plant recently installed at Sparrow's Point, Md. 1200 w. Elec Rev, N Y—Sept. 19, 1903. No. 57929.

Compensation.

On Compensation of Asynchronous Motors. H. S. Meyer. Discusses the pros and cons of the question of compensating and compounding alternating-current machines. 2400 w. Elect'n, Lond—Sept. 4, 1903. No. 57842 A.

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Cranes.

Improvements in Electrically Operated Forge Cranes (Neuerungen an Elektrisch Betriebeuen Schmiede-Kranen). E. Becker. With details of bridge, trolley, and hoisting gear, together with special forms of blocks and chain connections. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1903. No. 58017 D.

Electric Drill.

An Ingenious Portable Electric Drill. Brief illustrated description of a portable electric drill, suitable for all descriptions of engineering work. 600 w. Sci Am Sup—Sept. 5, 1903. No. 57773.

Electric Drill for Boring Up-Hill in Mine Galleries. From *Revue Technologique.* Illustrated description. Col Guard —Sept. 11, 1903. No. 57908 A.

Electric Motors.

Electric Motors: Their Theory and Construction. H. M. Hobart. The first article of a second series, investigating the conditions leading to the most satisfactory design of polyphase motors. Ill. 6800 w. Trac & Trans—Sept., 1903. Serial. 1st part. No. 57851 E.

Elevators.

The Otis Elevator Company's Electric Elevator for Private Residences. Report of the Committee on Science and the Arts, of the Franklin Inst. 1200 w. Jour Fr Inst—Sept., 1903. No. 57976 D.

Fire Alarm.

Electro-Telethermometer of Juan Vila Forns. Brief illustrated description of a device for automatically announcing at any distance an elevation of temperature in its vicinity. 400 w. Sci Am—Sept. 12, 1903. No. 57815.

The Siemens and Halske Fire Alarms. Illustrated description. 1500 w. Sci Am Sup—Sept. 19, 1903. No. 57892.

Induction Motors.

A Graphical Analytical Investigation of the Single Phase Induction Motor (Der Einphasige Induktionsmotor in Grapishch Analytischer Darstellung). J. K. Sumec. An extension of the method of Görges with simplification of the expressions and application of graphical diagrams. 2000 w. Zeitschr f Elektrotechnik—Sept. 6, 1903. No. 58078 D.

A New Single-Phase Motor. L. Schüler, in *Elektrotechnische Zeitschrift.* An illustrated description of an alternating current motor working on the rotary-field and the repulsion principle. Ill. 3000 w. Elec Engr, Lond—Sept. 4, 1903. No. 57839 A.

The Induction Motor and Its Engineering Capabilities. George L. Hoxie. A thesis presented for the degree of Doctor of Philosophy. Gives a detailed study of a particular motor and of the behavior of the magnetic circuit in the present number. Ill. 6800 w. Jour Fr Inst—Sept., 1903. Serial. 1st part. No. 57975 D.

The Theory of Non-Synchronous Single Phase Motors (Zur Theorie des Asynchronen Einphasenmotors). Fritz Emde. A mathematical discussion of the theory of Görges, transforming the relations to render them applicable to the case of two rotating fields. 2000 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58061 B.

Live Rolls.

Electrically Driven Live Rolls (Ein Elektrisch Betriebener Blockrollgang). F. Janssen. Illustrating the operation of a set of live rolls for rolling mill feed by means of electric group driving with details and diagrams of operation. 1800 w. Stahl u Eisen—Sept. 1, 1903. No. 58033 D.

Machine Driving.

The Electric Drive as Applied to Machine Tools, with Special Reference to Railroad Shops. C. H. Hines. Outlines briefly what has been chosen as the equipment of a large railroad shop in the United States. 1600 w. Elec Wld & Engr—Sept. 19, 1903. No. 57930.

Mines.

Electricity in Mines. T. Campbell Futers. Discusses the details of the application of electricity to mine work, the causes of dissatisfaction and the remedies. Ill. 1600 w. Elec Rev, Lond—Aug. 21, 1903. Serial. 1st part. No. 57574 A.

Motor Losses.

See Electrical Engineering, Measurement.

Niagara Falls.

Developments at Niagara Falls for the Utilization of Its Power. An illustrated article reviewing the progress being made on both sides of the river. 2800 w. Elec Rev, N Y—Sept. 12, 1903. No. 57879.

Pumping.

Electric Motors for Centrifugal Pumps and Fans. Aug. J. Bowie, Jr. Study of the problem of determining the proper capacity of a motor in the case of centrifugal pumps and fans. 2300 w. Trans Am Inst of Elec Engrs—Sept., 1903. No. 57969 D.

Repair Shops.

Electricity in Railroad Repair Shops. An illustrated description of buildings of monolithic concrete construction and the electrical equipment of the Central Railroad Shops at Elizabethport, New Jersey. 2800 w. Am Elect'n—Sept., 1903. No. 57777.

Speed Control.

Electrical and Mechanical Methods of

Variable Speed Control. William Cooper. Abstract of paper read at Chicago meeting of the Nat. Elec. Lgt. Assn. Explains the various methods and devices used, comparing the electrical and mechanical methods. 5600 w. Ir Trd Rev—Sept. 10, 1903. No. 57867.

The Regulation of Polyphase Motors (Regulierung von Drehstrommotoren). Walter Burkard. A discussion of the various methods of regulating the speed of polyphase motors, with especial reference to a special form of motor composed of multiple elements capable of having the connections changed. 2500 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58060 B.

TRANSMISSION.

Converters.

Compound Wound vs. Shunt Converters. P. M. Lincoln. Discusses the advantages and disadvantages of the compound wound as compared with the shunt rotary. 2500 w. St Ry Jour—Aug. 29, 1903. No. 57678 C.

Notes on the Theory and Working of Rotary Converters. W. Rogers explains the characteristics, the methods of working, etc., and considers the advantages and disadvantages of the rotary converter as a transformer for alternating and continuous currents. Diagrams. 3500 w. Elec Engr, Lond—Sept. 11, 1903. No. 57899 A.

High-Pressure.

An Efficient High-Pressure Water-Power Transmission Plant. George A. Henry, Jr., and Joseph N. Le Conte. An illustrated article describing an interesting hydraulic plant in Southern California, used for transmitting power to Los Angeles, and for irrigation pumping in the San Gabriel Valley. 3000 w. Trans Am Inst Elec Engrs—Sept., 1903. No. 57967 D

Protective Devices for High-Tension Electrical Systems. W. B. Woodhouse. Read before the British Assn. Discusses several points in connection with the operation of a high-tension polyphase transmission system. Ill. 2700 w. Elec Engr, Lond—Sept. 18, 1903. No. 57992 A.

Regulation.

Regulation of Transmitted Power. Alton D. Adams. Considers the work of regulation in transmission systems. 3300 w. Elec Rev, N. Y.—Sept. 12, 1903. No. 57878.

MISCELLANY.

Lecture.

Electricity and Matter. Sir Oliver Lodge. A lecture delivered at Bedford College for Women. 3800 w. Sci Am Sup—Sept. 26, 1903. No. 57963.

Report.

The German Electrotechnical Society (Verband Deutscher Elektrotechniker). Report of the annual meeting, with regulations for standard installtion details, together with the discussions. Two articles. 30,000 w. Elektrotech Zeitscher—Aug. 13, 20, 1903. No. 58056. Each B.

GAS WORKS ENGINEERING

Carbon Monoxide.

On Some Details of the Estimation of Carbon Monoxide. Charles R. C. Tichbourne. Lecture before the Irish Assn. of Gas Mgrs. Describes the making of the solution and the method of working. 2000 w. Gas Wld—Aug. 22, 1903. No. 57567 A.

Cheaper Gas.

The Need of Cheaper Gas. C. E. Jones. A review of the gas industry, the questions of present importance and the future outlook. 3500 w. Jour Gas Lgt—Sept. 1, 1903. No. 57797 A.

Conveying.

The Mechanical Conveying of Coal and Coke. Emile Guarini. Illustrates and describes the apparatus installed by the Paris Gas Co. 1100 w. Sci Am Sup—Sept. 12, 1903. Serial. First part. No. 57817.

Croydon.

The Croydon Gas Works. Their Present and Past. Plan of extensions, with description and historical notes. 3300 w Jour Gas Lgt—Sept. 1, 1903. No. 57796 A.

Extensions.

Extensions at the Evesham Gas-Works. R. J. Milbourne. An illustrated description of a purifying installation; the chief novelty consisting in the fact that there are no connections or external valves in the ordinary sense of the term. 1800 w. Jour Gas Lgt—Aug. 18, 1903. No. 57568 A.

Gaseous Fuel.

Notes on the Production and Characteristics of Gaseous Fuel. B. H. Thwaite. Describes a gasifying system. 1800 w Engr, U S A—Sept. 15, 1903. Serial. First part. No. 57925 C.

We supply copies of these articles. See page 315.

Gas Works.

Steel Building Construction in Gas-Works. Samuel Cutler, Jr. Refers particularly to buildings for inclined retort benches and carburetted water gas plants, discussing the use of corrugated sheeting, and giving illustrated descriptions of various buildings. Also discussion. 7000 w. Gas Wld—Sept. 19, 1903. No 57989 A.

Incandescence.

Incandescent Gas Lighting (L'Incandescence par le Gaz). Ch. Féry. A study of the conditions required for successful gas lighting by incandescent mantles, with an examination of the theory. 1500 w. Génie Civil—Aug. 8, 1903. No. 58019 D.

Variations in the Lighting Power in the Incandescent Burner of Combustible Gases. E. Sainte-Claire Deville. Abstract translation of a paper presented to the International Photometric Committee. A discussion of the photometry of the gas and of the mantle and the subject of incandescent lighting in general. 3700 w. Jour Gas Lgt—Aug. 25, 1903. Serial. First part. No. 57705 A.

Natural Gas.

Notes on the Occurrence of Natural Gas at Heatsfield, Sussex. H. B. Woodward. Abstract from the Memoirs of the Geol. Surv., giving information concerning their deposits. 1500 w. Ir & Coal Trds Rev—Aug. 28, 1903. No. 57730 A.

Purification.

Notes on Gas Purification. Dr. H. Bunte. Abstract translation of a reprint in the *Jour. für Gasbeleuchtung* of a lecture delivered before the German Assn. of Gas & Water Engrs. 1700 w. Jour Gas Lgt—Sept. 15, 1903. Serial. First part. No. 57905 A.

Slot-Meters.

Slot-Meter Agreements. J. Duncan. Reviews English law and practice with regard to slot-meter agreements, giving a model. 5300 w. Gas Wld—Sept. 5, 1903. No. 57833 A.

Sulphur.

The Relation of Sulphur in Lighting Gas to Air Vitiation. J. S. Haldane. Reprinted from the *Jour. of Hygiene*. Concludes that unpleasantness of air vitiated by lighting gas is due to sulphur, and that gas purified from carbon bisulphide is greatly superior from the hygienic standpoint to gas which is only purified from sulphuretted hydrogen. 2700 w. Jour Gas Lgt—Sept. 1, 1903. No. 57798 A.

Testing Still.

The Testing Coal Tar and Oils and an Improved Testing Still. H. W. Jayne, in *Jour. Am. Chem. Soc.* Describes this still and the methods used. 1200 w. Am Gas Lgt Jour—Sept. 7, 1903. No. 57743.

Waste.

Unaccounted for Gas. Jno. Paterson. Read before the Irish Assn. of Gas Mgrs. Gives the writer's methods by which he brought the leakage down from 17 to 3½ per cent. General discussion. 4200 w. Gas Wld—Aug. 22, 1903. No. 57566 A.

Water Gas.

The Extension of Coal Gas Works by Use of Water Gas Plants (Die Erueiterung von Kohlen gaswerken durch Wassergasanlagen). Franz Walter. A description of the extent to which existing illuminating gas plants may be increased in capacity by the addition of water gas apparatus; with a description of the plant at Reichenberg, Bohemia. 3500 w. Zeistchr d Oesterr Ing u Arch Ver—Sept. 11, 1903. No. 58039 D.

INDUSTRIAL ECONOMY

Apprenticeship.

Apprenticeship in Engineering Training. Prof. John Dewar Cormack. A discussion of the best training and the conditions that should be fulfilled. 1800 w. R R Gaz—Sept. 11, 1903. No. 57828.

British Iron Trade.

The Future of the British Iron Trade as Affected by Pending Tariff Proposals. A discussion of the present situation and future outlook. 12800 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57865 A.

Cost System.

A Shop Cost System. Lin. Wood. Describes a system for finding and keeping the shop cost of work produced, which may be applied to almost any shop. 1400 w. Am Mach—Aug. 27, 1903. No. 57606.

Methods of Calculation in Machine Construction (Ueber Kalkulations-Methoden in Maschinenbau). Sigm. Stephan Récsei. A discussion of the fundamental methods of computing factory costs in machine building, deriving formulas, and comparing methods of wages, depreciation, inventory, etc. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 7, 14, 1903. No. 58037 each D.

Education.

College or Apprenticeship. Louis H.

We supply copies of these articles. See page 315.

Ransome. A consideration of the two systems of training, with a view to seeing in what direction improvements should be sought. 2000 w. Engr, Lond—Aug. 21, 1903. No. 57585 A.

Labor.

The American Negro for South America. D. H. Newland. Discusses the question of introducing negro labor from the United States. The investigations made do not recommend the negro as an efficient laborer. 2000 w. Eng & Min Jour—Aug. 29, 1903. No. 57627.

Labor Management.

The Issues Between Labor and Capital. Egbert P. Watson. An impartial discussion of the faults of trade unionism and the mistakes of employers. 3000 w. Engineering Magazine—Oct., 1903. No. 58 086 B.

Premium System.

Experience with the Premium and Piece-Work Systems. R. J. Sutton. Discusses the attitude of labor organizations. 2400 w. Ir Trd Rev—Sept. 3, 1903. No. 57752 C.

The Premium System of Wages (Das Prämiensystem der Lohnberechnung). B. Schiller. A scientific examination of the Halsey premium system in comparison with day wages, also considering the Rowan modification and a method of the writer, together with piece work. 7500 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 1903. No. 58014 D.

Unskilled Labor.

Famine Works in India. E. O. Mawson. An explanation of the system generally adopted for the management of these large camps of unskilled laborers. Ill. 3500 w. Engr, Lond—Aug. 28, 1903 No. 57718 A.

Waste.

The Utilization of Waste. Editorial calling attention to some cases where success has been attained and discussing the causes of some failures. 2400 w. Engng —Aug. 28, 1903. No. 57728 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Size and Character of American Battleships. George W. Melville, in *American Industries*. Shows that decreasing the size of battleships is not desirable. 2400 w. Marine Rev—Sept. 3, 1903. No. 57734.

Cruisers.

Steam Trials of H. M. S. "Cumberland." Reports satisfactory results of official trials on the Firth of Clyde. 600 w. Engng—Sept. 11, 1903. No. 57911 A.

Ferryboat.

Ellis Island Ferryboat. An illustrated detailed description of a new boat for special service. 1800 w. Marine Engng—Sept., 1903. No. 57610 C.

Fire Boats.

The Evolution of the Fire Boat. An illustrated article showing the development in the United States. 2000 w. Fire & Water—Sept. 5, 1903. No. 57735.

Liners.

Three New Liners. Illustrations with brief descriptions of three vessels for the South Africa route. The Arundel Castle, Cluny Castle, and the Miltiades. 1400 w. Engr, Lond—Aug. 21, 1903. No. 57588 A.

Race.

Motor Boat Race. Paris-Rouen-Trouville. An illustrated article giving an account of the race. 1300 w. Auto Jour—Sept. 5, 1903. No. 57835 A.

Ship Yard.

Fore River Ship and Engine Works, Quincy Mass. Illustrations, with description, of cranes and the fixed structure in use. A separate rapid crane of small capacity is provided for each side of each ship. 1200 w. Engng—Sept. 11, 1903 No. 57909 A.

Speed Trial.

Remarkable Run of the Kearsarge Across the Atlantic. An account of the run of the U. S. battleship "Kearsarge" from Portsmouth, Eng., to the coast of Maine, covering 2,885 nautical miles in 219 hours, 30 minutes. Ill. 1100 w. Marine Engng—Sept., 1903. No. 57611 C.

Stability.

The Stability of a Modern Steamship with a Leak in the Starboard Engine Room (Untersuchung über die Stabilität eines modernen Schnelldampfers beim Leckwerden des Severbord-Maschinenraumes). Matthias Esser. A graphical analysis of the stability of a twin-screw steamship when one engine room is filled with water. Serial. Part 1. 2000 w. Schiffbau—Aug. 23, 1903. No. 58034 D.

Towboat.

Steel Towboat Sprague. Illustration, with description of the largest towboat

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ever built for the Mississippi river. To be used in taking the immense fleets of coal barges down the river. 3800 w. Marine Engng—Sept., 1903. No. 57612 C.

Yachts.

Development of the 90-Foot Racing Yacht. Traces briefly the development that has taken place during the half-century of yacht racing contests. Ill. 2000 w. Sci Am—Aug. 29, 1903. No. 57615.

Efficiency at Sea. William W. Bates. Discusses the scientific design of racing yachts, and points having a bearing on the carriage, speed and efficiency of vessels

1800 w. Naut Gaz—Sept. 17, 1903. No. 57920.

Stern-Wheel Steam Yacht Fortuna. An illustrated description of a boat which embodies the advantages of the house-boat and also permits of navigating shallow streams at a good speed. 1000 w. Marine Engng—Sept., 1903. No. 57609 C.

The "Shamrock"-"Reliance" Races of 1903. Illustrations, with account of the first two finished races. 1400 w. Sci Am—Sept. 5, 1903. No. 57771.

Turbine Yachts at the International Races. Illustrations, with brief notes. 900 w. Sci Am—Sept. 5, 1903. No. 57769

MECHANICAL ENGINEERING

Competition.

The Deauville 500-Meter Competition. An illustrated account of the contest. 800 w. Auto Jour—Sept. 19, 1903. No. 57988 A.

Fuels.

Fuels for Motor Cars. The first of a series of articles introducing a discussion of suitable fuels. 1300 w. Autocar—Sept. 5, 1903. Serial. 1st part. No. 57837 A.

Heavy Oils.

The Problem of Heavy Oil for Automobile Engines. A letter on "Kerosene for Explosion Engines," with editorial comments. 3300 w. Auto Jour—Aug. 29, 1903. No. 57697 A.

Motor.

A Great Traction Motor. Brief illustrated description of a tractor used in Michigan for hauling logs during the winter season. 1000 w. Rev of Revs—Sept. 1903. No. 57692 C.

Motor Cars.

The Gobron-Brillié Cars. Illustrates and describes these cars in which balanced petrol engines are used. 3200 w. Auto Jour—Sept. 12, 1903. Serial. 1st part No. 57897 A.

The Wolseley Motor Car. Alex. Richardson. Illustrated detailed description of a typical car manufactured in Birmingham, Eng., and the making. 4800 w. Trac & Trans—Sept., 1903. No. 57849 E.

Motor Cycles.

The Tourist Motor Cycle 1,000 Miles Reliability Trials. An illustrated account of these trials in England. 800 w. Auto Jour—Aug. 22, 1903. No. 57569 A.

Motor Traction.

A New System of Motor Traction. A. W. Brightmore. Describes the writer's work in this field and the vehicle which is the final outcome. The front wheels are the driving wheels and also the steering. Ill. 5000 w. Mech Engr—Sept. 5, 1903. No. 57838 A.

Petrol Cars.

The Dennis Petrol Cars. An illustrated detailed description, calling attention to their leading characteristics. 2500 w. Auto Jour—Aug. 29, 1903. No. 57695 A.

Speed Gear.

The Newman-Gradually-Variable Speed Gear. Illustrated description of a change-speed gear which gives any speed from zero up to a certain limit. 1400 w. Auto Jour—Sept. 12, 1903. Serial. 1st part. No. 57898 A.

Steam Lurry.

The Savage Steam Lurry. Illustrated detailed description. 1700 w. Auto Jour—Sept. 5, 1903. No. 57836 A.

Steering.

Automobile Steering Mechanism. Brief illustrated descriptions of devices now used. 1600 w. Automobile—Sept. 19, 1903. No. 57918.

HYDRAULICS.

Centrifugal Pumps.

Theory of Centrifugal Pumps and Fans. Analysis of their action, with suggestions for designs. Discussion of the paper by Elmo G. Harris. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1903. No. 58114 E.

Electric Pumping.

See Electrical Engineering, Power Applications.

Flow.

An Experimental Study of the Resistances to the Flow of Water in Pipes. Discussion of the paper by Augustus V. Saph,

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and Ernest W. Schoder, Jr. 3800 w. Pro Am Soc of Civ Engrs—Sept., 1903. No 58112 E.

House Drainage.

The Inefficiency of Modern House Drainage. William R. Purchase. Discusses the defects of stone-ware pipe, and considers needed improvements. 1400 w Builder—Sept. 19, 1903. No. 57987 A.

Pump Formulas.

Rules and Formulas for Steam Pumps and Water Pipes. C. A. Collett. Reviews the rules for finding the velocity of flowing water, the weight and pressure of columns of water of various heights, and deduces formulae, illustrating by examples. 3500 w. Engr, U.S.A.—Sept. 1, 1903. No. 57776 C.

Pumps.

Some Pump Troubles, Their Causes and Remedies. L. S. Rrainard. Considers troubles with steam pumps. Ill. 1800 w. Power—Sept., 1903. No. 57650 C.

Units.

A Suggested Hydraulic Unit. Ralph L. Montague. Suggests that a new unit composed of one cubic foot of water per minute under one foot head be recognized. 300 w. Trans Am Inst of Elec Engrs—Sept., 1903. No. 57968 D.

MACHINE WORKS AND FOUNDRIES.

Brass Melting.

Melting Rates in Brass Foundries. John F. Buchanan. A discussion of the best fuels, methods, the melting ratio, &c. 1700 w. Foundry—Sept., 1903. No. 57982.

Camming.

Directions for Camming the Brown & Sharpe Automatic Screw Machine. R. E. Flanders. 4800 w. Ill. Mach, N. Y. —Sept., 1903. No. 57662 C.

Case-Hardening.

Case-Hardening. A. W. McCaslin. Read before the Nat. R. R. Blacksmith's Assn. Explains the meaning of the term and the methods used, best material, &c. 1700 w. Am Mach—Sept. 10, 1903. No. 57809.

Castings.

Manufacture of Sound Castings by Means of Thermit. J. B. Nau. Reviews statements made by W. Mathesius, in the Aug. 15 issue of *Stahl und Eisen*, with which the writer fails to agree. 3300 w. Ir Age—Sept. 10, 1903. No. 57766.

The Use of Thermite for the Production of Sound Castings and Forgings (Herstellung von Poren und Lunkenfreiem Grauguss, Stahlguss, und Schmiedestücken durch Anwendung von Thermit). W. Mathesius. Describing the methods of using a mixture of aluminum and iron oxide for effecting complete fusion and the production of steel and iron castings without blow holes. 2500 w. Stahl u Eisen—Aug. 15, 1903. No. 58030 D.

Cranes.

See Electrical Engineering, Power Applications.

Dies.

A Nice Job in Bending and Forming. Joseph V. Woodworth. Illustrated description of dies and work. 600 w. Am Mach—Sept. 3, 1903. No. 57761.

Die Work for Medals, Jewelry, and Art Goods. Joseph V. Woodworth. Describes methods used. 2300 w. Am Mach—Aug. 27, 1903. No. 57607.

Electric Driving.

See Electrical Engineering, Power Applications.

Foundries.

The Continuous Operation of the Iron Foundry. John C. Knocppel. Read at meeting of the Am. Found. Assn. Considers features that should be considered before deciding upon continuous operation. 2000 w. Foundry—Sept., 1903. No. 57981.

Grinding.

Emery Wheel Practice in Foundries. Charles G. Smith. Read before the Pittsburg Foundrymen's Assn. Discusses conditions needed to secure good results, and points of importance in grinding. 3000 w. Ir Age—Sept. 10, 1903. No. 57767.

Gripping Tongs.

Rolling Mill Dogs. Ulrich Peters. Illustrates and describes types of gripping tongs, or automatic methods of gripping. 1100 w. Am Mach—Sept. 24, 1903. No. 57952.

Hardening.

A few Points in Hardening. E. R. Markham. Suggestions for treatment 700 w. Am Mach—Sept. 24, 1903. No. 57953.

Lathe Fixtures.

Some simple Lathe Fixtures. William Doran. Illustrates and describes devices for rapid handling and machining duplicate parts in the lathe, miller, and drill press. 700 w. Am Mach—Sept. 3, 1903. No. 57762.

Locomotive Works.

The Darlington Works of Robert Stephenson and Co. The first of a series of articles giving the history and detailed description of these works. 3000 w. Engr, Lond—Sept. 11, 1903. Serial. 1st part. No. 57913 A.

Metallurgical Engineers.

The Metallurgical Engineer in the Foundry. Henry Souther. Read at meeting of

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the Am. Found. Assn. Considers his value and discusses some objections made to such service. 1800 w. Foundry—Sept., 1903. No. 57984.

Molding.

Machine and Floor Plate Molding. C. Neil. An illustrated description of this type of molding. 1700 w. Am Mach—Sept. 17, 1903. No. 57871.

Piston-Rings.

Cast Iron for Piston-Rings. C. H. Wingfield. Read before the British Assn. Considers the permanent set in cast iron due to small stresses, and its bearing on the design of piston-rings and springs. Ill. 2500 w. Engng—Sept. 18, 1903. No. 58102 A.

Records.

Pratt's Record Scroll. Horace L. Arnold. Illustrates and describes this scroll, and states its advantages. 1400 w. Am Mach—Sept. 17, 1903. No. 57872.

Rolling Mill.

Universal Triple Rolling Mill (Universal Trio Walzwerk). Illustrated description of a powerful vertical triple rolling mill built at the Sack Machine Works near Düsseldorf. 1800 w. 1 plate. Stahl u Eisen—Aug. 15, 1903. No. 58031 D.

Rolls.

The Calibration of Rolls (Walzenkalibrierung). A. Sattmann. A discussion of the correct form and dimensions to be given to the passes in rolling-mill rolls for special shapes. 3000 w. Stahl u Eisen—Sept. 1, 1903. No. 58032 D.

Scrap.

Sorting Scrap Iron. Walter J. May. Hints on the sorting and use of this material. 700 w. Prac Engr—Sept. 18, 1903 No. 57990 A.

Screw Threads.

Casting Fine Threads in Gray Iron. John Randol. An illustrated description of interesting work. 1800 w. Am Mach—Sept. 3, 1903. No. 57764.

Shops.

A Model Bridge and Construction Shop. An illustrated detailed description of the Pennsylvania Steel Company's new plant at Steelton, Pa. The finest bridge shop in the United States. 3500 w. Ir Age—Sept. 10, 1903. No. 57765.

Machine Shop Equipment. Oscar E. Perrigo. The present article considers planning the different departments, suggesting the proper selection and arrangement of machines. 3700 w. Ill. Mach, N. Y.—Sept., 1903. Serial. 1st part. No. 57663 C.

The Inland Steel Company's Indiana Harbor Works. Illustrated detailed description of these works and their equipment. 2000 w. Ir Age—Sept. 3, 1903. No. 57667.

The Nuremberg Shops of the Nuremberg and Augsburg Machine Works (Das Neue Werk der Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A. G.). A fully illustrated description of the new shops at Nuremberg belonging to the great Augsburg combination. Three articles, three plates. 9000 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 29, Sept. 12, 1903. No. 58013 each D.

The Reconstructed Shop of the Betts Machine Co. Illustrated detailed description. 2300 w. Mach, N. Y.—Sept., 1903. No. 57665 C.

Steep Pipes.

The Manufacture of Weldless Steel Pipes and Shells. Heinrich Ehrhardt. Read before the Iron & Steel Inst. An illustrated description of the process. 900 w. Ir Age—Sept. 17, 1903. No. 57869.

Wheels.

Making a Wheelbarrow Wheel. John Randol. Illustrated detailed description of the work as carried on in an Ohio shop. 2200 w. Am Mach—Sept. 3, 1903. No. 57760.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Copper and Magnesium (Les Alliages de Cuivre et de Magnesium). O. Boudouard. A microscopic study with micro-photographs of polished and etched surfaces of various alloys of copper and magnesium. 2000 w. Bull Soc d'Encour—Aug., 1903. No. 58035 G.

Alloys of Iron and Tungsten. R. A. Hadfield. Read before the Iron & Steel Inst. Abstract of the first part of this important paper, with the complete second part. A report of researches. 4000 w. Engng—Sept. 14, 1903. Serial. 1st part. No. 57855 A.

Corrosion.

The Influence of Sea Water on Copper and Copper Alloys (Einwirkung des Seewassers auf Kupfer und einige Kupferlegierungen). H. Diegel. Data and results of experiments upon the corrosion of copper sheets and pipes. 3500 w. Glasers Annalen—Sept. 1, 1903. No. 58023 D.

Inspection.

The Inspection of Materials. Part first considers the need and aim of inspections and whether good work is assured by the present system. 3700 w. Engr, Lond—Sept. 4, 1903. Serial. 1st part. No. 57857 A.

The Inspection of Rails. C. W. Gennet, Jr. A discussion of the inspector's duties.

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2000 w. R R Gaz—Aug. 28, 1903. No. 57640.

Metallography.

The Utilization of Microscopic Metallography as a Method of Testing (La Métallographie Microscopique et son Utilisation comme Méthode d' Essais). Léon Guillet. A study of the practical applications of the methods of metallography to the determination of the quality of materials of construction. 10000 w. 1 plate. Mem Soc Ing Civ de France—July, 1903. No. 58027 G.

Metal Protection.

Lacquers and Paints for Metals. The first of a series of articles on compounds for protection or embellishment of metallic surfaces, and the proper way of applying them. 3000 w. Engr, Lond—Sept. 11, 1903. Serial. 1st part. No. 57915 A.

Metals.

The Physical Properties of Metals (Die Physikalischen Eigenschaften der Metalle). J. Traube. A comparison of the properties of metals according to the conditional equations of Van der Waals. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1903. No. 58012 D.

Nickel Steel.

Recent Researches on Nickel Steels (Nouvelles Recherches sur les Aciers au Nickel). Léon Guillet. Developing a diagram from which the properties of a steel may be predicted from a knowledge of the nickel and carbon content. 2500 w. Bull Soc d' Encour—Aug., 1903. No. 58036 G.

The Theory of Nickel Steels (A Propos de la Théorie des Aciers au Nickel). L. Dumas. A review of the theory recently set forth by Guillaume, showing its incompleteness and suggesting further extension of the allotropic theory to alloys of nickel and steel. 2000 w. Rev Gen des Sciences—Aug. 15, 1903. No. 58051 D.

The Theory of Nickel Steels (Contribution à la Theorie des Aciers au Nickel). F. Osmond. A review of the theory of Guillaume, agreeing in general with the application of the allotropic theory to the phenomena exhibited by nickel steels, and adding the results of further experiments upon the magnetic properties of the various alloys. 3000 w. Rev Gen des Sciences—Aug. 30, 1903. No. 58052 D.

Pig Iron.

See Mining and Metallurgy, Iron and Steel.

Steel.

See Mining and Metallurgy Iron and Steel.

Tool Steel.

Comparative Trials of High Speed Steels. Gompei Kuwadi. Describes trials and gives results. 1200 w. Am Mach—Sept. 3, 1903. No. 57763.

Rapid Tool Steels. Editorial on the recent improvements in tool steels, the tests made and what they show. 2700 w. Engng—Aug. 21, 1903. No. 57582 A.

MEASUREMENT.

Calculator.

The Calculator Board and Graphic Methods. Illustrates and describes an improved drawing board and apparatus for facilitating graphic methods of calculation, and the like. 1600 w. Elec Rev, Lond—Aug. 28, 1903. No. 57712 A.

Constants.

Determining Design Constants from Practice. Sanford A. Moss. Gives a method of working up known facts so as to obtain the various stresses, bearing pressures, and other design constants. 2700 w. Am Mach—Sept. 24, 1903. No. 57951.

Graphics.

Illustrations of Graphical Analysis. J. Harrison. Read before the British Assn. A short account of applications of graphical processes to engineering computations which do not require undue labor. 1500 w. Engng—Sept. 18, 1903. No. 58103 A.

Locomotive Proportion by Graphical Methods. F. K. Caswell. The first of a series of graphical charts dealing with problems in locomotive design. 1300 w. Ry & Engng Rev—Sept. 5, 1903. No. 57756.

Indicator Diagrams.

Steam Engine Diagrams. Gives diagrams of a tandem compound engine of vertical marine type without condensation, explaining the information obtained from them. 1700 w. Naut Gaz—Sept. 17, 1903. No. 57919.

Micrometers.

Measuring Instruments of High Precision (Instruments de Mesure de Haute Précision). A. Galassini. Especially describing the micrometers of Bariquand & Marre, as adapted for precise measurements in the workshop. 7000 w. Revue de Mécanique—July 31, 1903. No. 58048 E + F.

Power Measurement.

Measuring the Horse-Power of Steam Engines. E. C. Oliver. Gives results of a series of tests which were intended to show the effect on the average horse-power of taking indicator diagrams at various intervals simultaneously and at various intervals in rotation. 1200 w. Power—Sept., 1903. No. 57649 C.

Pyrometry.

The Application of the Laws of Radiation to Pyrometery (L' Application des

Lois du Rayonnement à la Pyrometrie). Ch. Féry. Describing a form of optical pyrometer, by means of which high temperatures may be measured from the radiant heat emitted. 2000 w. Rev Gen des Sciences—Sept. 15, 1903. No. 58053 D.

Testing.

The Testing Laboratory of the Conservatoire des Arts et Metiers (Laboratoire des Essais lu Conservatoire des Arts et Métiers). P. Breuil. A general description of the new mechanical laboratory in Paris, with illustrations of the hydraulic machinery and testing appliances. Serial. Part I. Génie Curl—Sept. 5, 1903. No. 58006 D.

POWER AND TRANSMSISION.

Aërial Tramways.

Aërial Tramways. Stephen de Zouiboria. Address before the Am. Min. Cong., at Deadwood. Considers the advantages of rope tramways, the systems, construction, cost of installation, etc. 2000 w. Ir Age—Sept. 24, 1903. No. 57950.

Compressed Air.

Compressed Air as a Motive Power Underground. T. G. Oliver. Abstract of a paper read before the Monkland Improvement and Debating Soc., Gympie, Q. Considers the serviceable pressure and the methods of application. 3300 w. Queens Gov Min Jour—July 15, 1903. No. 57699 B.

Conveying.

See Gas Works Engineering.

Elevators.

A New Spiral Elevator. Illustrated description of a novel type of elevator. 900 w. Eng Rec—Aug. 29, 1903. No. 57637.

Gearing.

The Choice of Angle of Obliquity for Involute Gearing (Sur le Choix de l'Obliquité de la Ligne d' Engrènement pom les Engrenages à Développante). Edmond Dubosc. A discussion of the effect of various angles of obliquity upon the interference of involute gear teeth. Serial. Part I. 3500 w. Revue de Mécanique—Aug. 31, 1903. No. 58049 E + F.

Gears.

Spiral Gears. C. E. Coolidge. Development of theory and rules for their calculation. 2000 w. Mach, N Y—Sept., 1903. No. 57666 C.

Hoisting.

Tests of the Efficiency of Hoisting Tackle. S. L. Wonson. A report of tests recently carried out by the erecting department of the American Bridge Co. of New York. 1000 w. Eng Rec—Sept. 12, 1903. No. 57882.

Tests of the Efficiency of Hoisting Tackle. S. P. Mitchell. A report of an extended series of tests made recently at the Pencoyd plant of the Am. Bridge Co. with standard types of blocks and various combinations of manila and wire rope. 800 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57681 E.

Lubrication.

Lubrication of Textile Mills. William F. Parish, Jr. Extracts from a paper before the New England Cotton Mfrs. Assn. Discusses difficulties due to oils, and other matters relating to proper lubrication of heavy machinery. 3600 w. Am Mach—Sept. 10, 1903. No. 57810.

Shafts.

Theory of Stiff and Flexible Shafts and Critical Speeds. Sanford A. Moss. A detailed mathematical study of this theory. Ill. 2500 w. Power—Sept., 1903. No. 57648 C.

Speed Gears.

A Simple Speed Reducing Gear. Brief illustrated description of the invention of J. Sinclair Fairfax. 250 w. Engr, Lond—Sept. 18, 1903. No. 58108 A.

SPECIAL MOTORS.

Alcohol.

The Manufacture of Ethyl Alcohol from Wood. Describes the Classen process for the economical commercial manufacture of ethyl alcohol from wood, and gives information concerning plants to be erected in the United States. Ill. 3000 w. Ir Age—Sept. 17, 1903. No. 57868.

Carburetters.

Alcohol Carburetters. Capt. C. C. Longridge. Considers the design of alcohol carburetters. 1500 w. Engr, Lond—Aug. 28, 1903. No. 57720 A.

Gas Engines.

A Further Note on Gas-Engine Explosions. H. E. Wimperis. Read before the British Assn. The writer in a former paper considered the experiments of Mr. Dugald Clerk; and in the present paper considers the experiments of Mr. Grover, comparing the two and endeavoring to reconcile the previously inconsistent results. 2500 w. Engng—Sept. 18, 1903, No. 58104 A.

Compression in the Gas Engine. W. H. Booth. Information on the degree of compression to which gas engines can safely be worked, with diagrams. 700 w. Elec Rev, Lond—Aug. 21, 1903. No. 57576 A.

Four-Cylinder Gas Engine. Illustrates and describes an engine designed to develop 150 horse-power, at a speed of 250 revolutions per minute using producer gas. 1000 w. Engr, Lond—Aug. 28, 1903. No. 57721 A.

We supply copies of these articles. See page 315.

Gas Engine Principles and Management. E. W. Roberts. Illustrates and describes the principles of the two types in general use, and of accessory devices for using liquid fuels, discussing the management, troubles, and related matters of interest. 6500 w. Eng News—Sept. 17, 1903. No. 57944.

The Gas Engine and the Gas Turbine. George E. Walsh. Discusses the probability of the gas turbine becoming a success, and the future of the gas engine. 1400 w. Elec Rev, N Y—Sept. 5, 1903. No. 57757.

The Large Gas Engine in Great Britain. William H. Barth. An illustrated study of its development and the influence of blast furnace gas, present practice, various types, etc. 4000 w. Cassier's Mag—Sept., 1903. No. 57939 B.

Kerosene vs. Gasoline.

Test of Engine Using Kerosene and Gasoline. H. F. Halladay and G. O. Hodge. Tests made to determine the economic performance of a standard internal-combustion engine using these fuels respectively, under otherwise similar conditions. 1700 w. Mech Engr—Aug. 22, 1903. Serial. 1st part. No. 57571 A.

Petroleum Motors.

Applications of Petroleum Motors to Navigation (Application des Moteurs à Pétrole à la Navigation). A. Bochet. Describing numerous applications, especially as an auxiliary to sailing vessels and for driving auxiliary machinery. 6000 w. 1 plate. Mem Soc Ing Civ de France—June, 1903. No. 58025 G.

STEAM ENGINEERING

Boilers.

Boiler Bracing. Charles L. Hubbard. The first of a series of articles giving directions for this work. 1200 w. Mach, N Y—Sept., 1903. Serial. 1st part. No. 57664 C.

Boiler Corrosion. Explains what corrosion is, and the different causes and various means by which it may be remedied or prevented. 2700 w. Mines & Min—Sept., 1903. No. 57595 C.

The Circulation of Water in Steam Boilers (La Circulation de l'Eau dans les Chaudières à Vapeur). A. Montupet. An exhaustive analysis of the nature and effect of circulation in boilers, and the extent to which it can be controlled and regulated. 15000 w. 1 plate. Mem Soc Ing Civ de France—June, 1903. No. 58024 G.

Water-Tube Boilers. Albert E. Lea. Read before the Engng. Assn. of N. S. W. Considers briefly the progress and development made in these boilers during the past thirty years, their advantages, etc., describing a Babcock & Wilcox boiler. 3000 w. Aust Min Stand—July 30 and Aug. 5, 1903. Serial. 2 parts. No. 57703 each B.

Boiler Setting.

A Modified Boiler Setting. John E. Sweet. Illustrated description. 700 w. Power—Sept., 1903. No. 57651 C.

Boiler Tubes.

Locomotive Boiler Tubes. Lawford H. Fry. Discusses the effect of tube spacing. 900 w. R R Gaz—Sept. 11, 1903. No. 57829.

Boiler Water.

A Plea for Better Boiler Water. John H. Wynne. Discusses the presence of scale-forming materials in water, the effect of scale upon boilers, impurities, etc. 2200 w. Ry Mas Mech—Sept., 1903. Serial. 1st part. No. 57731.

Circulating Pipe.

The Sheedy Circulating Pipe for Locomotive Cylinders. Illustrates and describes the device and its operation. 700 w. Am Engr & R R Jour—Sept., 1903. No. 57659 C.

Condensers.

A 6,000 Horse-Power Conover Jet Condenser. Illustrated description. 1700 w. Power—Sept., 1903. No. 57647 C.

Surface Condensing Plant for Coal and Iron Works. Illustrates and describes an interesting plant recently installed in England, designed to deal with the exhaust from two winding engines, one fan engine, and two Parsons turbine electrical generators. 1600 w. Engng—Sept. 4, 1903. No. 57853 A.

Cylinders.

Cutting of Cylinders. Charles H. Garlick. Discusses the causes of cutting. 1500 w. Engr, U S A—Sept. 1, 1903. No. 57775 C.

Engine Test.

Test of a 250 H. P. Tandem Compound Engine by Van den Kerchove, of Ghent (Untersuchung einer von Van den Kerchove in Genut gebauten Tandemmaschine von 250 P S). Prof. M. Schröter and A. Koob. Data and results of tests with saturated and superheated steam, showing a gain of 17 per cent. by superheating. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1903. No. 58016 D.

Engines.

The Lefèvre Four-Cylinder High-Speed Engine. Illustrates and describes an ingenious type of steam-engine. 1000 w. Engng—Aug. 28, 1903. No. 57725 A.

Fire Boxes.

Defects in Locomotive Fireboxes and the Brotan Tubular Firebox (Defekte au

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Lokomotivkesseln Normaler Bauart und das Neue Lokomotiv-Rohrboxkessel System Brotan). J. Brotan. An examination of the weakness of stayed fire boxes for locomotive boilers, and a description of a design constructed of water tubes. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 21, 28, 1903. No. 58038 each D.

Piping.

The High-Pressure Steam Piping at the Düsseldorf Exhibition (Die Hochdruck-Dampfrohrleitungen auf der Ausstellung in Düsseldorf). W. Stahl. With plans of the steam mains and general management of the connections to the boilers. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 22, 1903. No. 58011 each D.

Reheaters.

The Use of Reheaters in Compound Engines. George H. Barrus. Abstract of a paper presented to the New England Cotton Mfrs. Assn. Gives results of tests made by the writer, discussing the effects noticed. 2000 w. Power—Sept., 1903. No. 57652 C.

Safety Valves.

Improvements in Steam Boiler Fittings (Neuerungen an Dampfkesselarmaturen). Discussing especially recent forms of balanced safety valves and pressure-reducing valves. 1800 w. Glückauf—Sept. 5, 1903. No. 58075 B.

Steam Turbines.

Recent Developments of the Steam Turbine. A. Rateau. An illustrated discussion of the latest types of steam turbine, including the low as well as the high pressure machines. 3500 w. Engineering Magazine—Oct., 1903. No. 58084 B.

Recent Steam Turbine Developments. W. L. R. Emmet. A discussion of design, with explanation of changes made, and report of tests. General discussion. 7500 w. St Ry Rev (Daily Ed)—Sept. 4, 1903. No. 57804 C.

The Steam Turbine (Die Dampfturbinen). A general description of the different types of steam turbine now in the market, showing their numerous applications for electrical and general driving. Two articles. 6000 w. Glückauf—Aug. 15, 22, 1903. No. 58072 each B.

The Curtis Steam Turbine and Its Manufacture. Illustrated detailed description of this turbine, its manufacture, and operation. 2500 w. Mach, N Y—Sept., 1903. No. 57661 C.

The Parsons Steam Turbine. G. R. Dunell. Gives a description of the elementary principles upon which the design is based, traces the development, and shows views of the various departments in the works at Heaton, near Newcastle-on-Tyne, where the land turbines are made. Also gives an illustrated description of the marine type. 10500 w. Trac & Trans—Sept., 1903. No. 57850 E.

Stuffing Boxes.

Engines and Pumps Without Stuffing Boxes. Andrew Watson. A paper read before the Min. Inst. of Scotland, on stuffing boxes without glands. Also abstract of discussion. Ill. 2000 w. Mech Engr—Aug. 29, 1903. No. 57704 A.

Superheating.

Superheating by Wire-Drawing. Frank Foster. Shows a diagram of the wire-drawing calorimeter, explaining its principle and discussing its value; also considers another method of superheating steam by wire-drawing. 1200 w. Feilden's Mag—Sept., 1903. No. 57964 B.

MISCELLANY.

Aeronautics.

Experiments and Observations in Soaring Flight. Wilbur Wright. An illustrated account of experiments made by the writer. Also short discussion. 7000 w. Jour W Soc of Engrs—Aug., 1903. No. 57979 D.

The Disclosure of a Secret, and the Application to Aërial Navigation. Sidney Orville Brown. A study of soaring birds, with suggestions for applying the same principle to aeroplanes. 1000 w. Sci Am Sup—Sept. 19, 1903. No. 57891.

The Flying Machine and Its Slow Development. A brief review of the development, discussing the various theories. 2500 w. Sci Am Sup—Sept. 12, 1903. No. 57818.

The Lebaudy Airship. Describes the general principles on which the machine is built, with special details of its construction. Ill. 2000 w. Auto Jour—Aug. 29, 1903. No. 57696 A.

The Spencer Airship for 1903. Frederick A. Talbot. An illustrated detailed description of the improved design. 1700 w. Sci Am—Sept. 5, 1903. No. 57772.

Applied Science.

Engineering and Chemistry (Ingenieurwissenschaft und Chemie). Dr. W. Ostwald. An address delivered at the Münich meeting of the Verein Deutscher Ingenieure, showing the extent to which the work of the engineer and the chemical technologist harmonizes. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 29, 1903. No. 58015 D.

Bottles.

Making Bottles by Machinery (Fabrication Mécanique de Bouteilles). H. Aurive. An illustrated description of the

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Appert system of making bottles, with a review of other mechanical methods. 3000 w. Rev Technique—Aug. 10, 1903. No. 58020 D.

Heat.

Laws of Heat Radiation. J. Blacklock Henderson. Read before the Glasgow Univ. Phys. Soc. An experimental study. 3700 w. Elect'n, Lond—Aug. 28, 1903. No. 57714 A.

Lead Burning.

The Art and Practice of Lead Burning by Aero-Hydrogen and Coal Gas. Arthur R. Baldwin. (Second Prize Essay). Considers what lead burning is, where necessary, advantages and disadvantages, and the work. Ill. 2400 w. Plumb & Dec—Sept. 1, 1903. No. 57831 A.

Machinery.

The Age of Machinery and Its Relation to Public Welfare (Das Maschinenzeitalter in Seinem Zusammenhang mit dem Volkswohlstand und der Sozialen Verpassung der Volkswirtschaft). Gustav Schmoller. An address delivered before the Münich convention of the Society of German Engineers showing the great influence of machinery upon civilization. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1903. No. 58010 D.

Ovals.

A New Method of Drawing Ovals (Un Nouveau Tracé des Ovales). M. LeClerc de Pulligny. Deriving a method of drawing an arch of five circular arcs closely approximating a true ellipse. 1200 w. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58047 E + F.

Sugar Works.

The Sugar Works of Ketzin, near Berlin (Sucrerie de Ketzin, près de Berlin). Illustrated description of large beet sugar plant. 1000 w. 1 plate. Génie Civil—Aug. 22, 1903. No. 58002 D.

Thermodynamics.

Entropy, or Thermodynamics from an Engineer's Standpoint. J. Swinburne. An explanation of the term as employed in the thermodynamics of reversible and irreversible changes, aiming to make the theory clear. 6500 w. Engng—Aug. 28, 1903. Serial. 1st part. No. 57724 A.

The Reversibility of Thermodynamics. J. Swinburne. Read before the British Assn. Proposes a different treatment of the subject of thermodynamics in the hope of making the science more easily understood. 5500 w. Elec Rev, Lond—Sept. 18, 1903. No. 57995 A.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

The Lignite Briquette Works of the Lauchhammer Company (Die Braunkolenbrikettfabrik der Aktiengesellschaft Lauchhammer). A description of the briquette works of Lauchhammer, Prussia, with details of the process by which the local brown coal is compressed into serviceable fuel. 2000 w. 1 plate. Glückauf—Aug. 29, 1903. No. 58073 B.

Coal Cutting.

The Use of Stanley Coal-Heading Machines in the Rapid Development and Working of the Nuneaton Colliery, Warwickshire. F. C. Swallow. On the geology of this district, the coal seams, the working and costs, with discussion. 2500 w. Col Guard—Sept. 11, 1903. No. 57907 A.

Coal-Field.

The Arkansas--Indian Territory Coal-Field. Franklin Bache. Describes the deposits and gives an account of the workings. 2800 w. Eng & Min Jour—Sept. 12, 1903. No. 57886.

Coke Ovens.

The Regulation of the Combustion and Distribution of the Temperature in Coke Oven Practice. D. A. Louis. Brief illustrated descriptions of a number of ovens and the practice followed, especially the Brunck system and the Bauer system. Ill. 4400 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57863 A.

Electric Powers.

See Electrical Engineering, Power Applications.

Fuel.

Coal as Fuel at Barrow-in-Furness. W. F. Pettigrew. An account of experiments made to find the relative value of coals obtained from various districts in England, Scotland and Wales. 3800 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57860 A.

Great Britain.

Re-Survey of the Carboniferous Strata in Derbyshire and Nottinghamshire. From the "Summary of Progress of the Geol. Surv.," 1902. Describes the work of examining these coal measures. 4000 w. Ir

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& Coal Trds Rev—Sept. 11, 1903. No. 57916 A.

The Coal Mining Industry of the United Kingdom. R. A. S. Redmayne. The first of a series of papers discussing the development of British coal mining. The present article deals largely with the historical portion of the subject. 3500 w. Engineering Magazine—October, 1903. No. 58082 B.

India.

Seebpore Coal. Frederick Grover. Information concerning a practical test made of this coal, pronouncing it satisfactory. 1500 w. Jour Soc of Arts—Sept. 4, 1903. No. 57873 A.

Lignite.

Notes on the Bohemian Lignite Industry (Einiges vom Böhmischen Braunkohlenbergbau). H. Prietze. An account of the methods used in working the brown coal deposits of northwestern Bohemia. 1500 w. Glückauf—Sept. 5, 1903. No. 58074 B.

Queensland.

Dawson-Mackenzie Coal Fields. B. Dunstan. Illustrated article giving information of the deposits, quality of the coal, etc. 800 w. Queens Gov Min Jour—July 15, 1903. No. 57698 B.

Selenium.

Selenium in Coke. J. F. Smith. Read before the Yorkshire Sec. of the Soc. of Chem. Ind. An account of investigations, giving results. 1000 w. Aust Min Stand—July 23, 1903. No. 57702 B.

South Wales.

The Coal Measures of Llanelly, Llannon, and Cross Hands, in the South Wales Coal Field. From the Memoirs of the Geol. Surv. 10000 w. Ir & Coal Trds Rev—Aug. 28, 1903. No. 57729 A.

Supplies.

Report of the Royal Commission on Coal Supplies. The first instalment of a digest of evidence taken last year before the Commission. The working of thin seams is considered in the present number. 5600 w. Col Guard—Aug. 28, 1903 Serial. 1st part. No. 57715 A.

West Virginia.

Analyses and Fuel Value of the Pittsburg Coal in the Fairmont Region of West Virginia. Frank Haas. Reprinted from W. Va. Geol. Survey. Shows the influence of different constituents upon the value of the coal. 3400 w. Mines & Min—Sept., 1903. No. 57597 C.

COPPER.

Bessemer Process.

The Bessemer Copper Process. Describes briefly the latest method of copper converting, under the improved process of Paul David. Ill. 900 w. Sci Am—Sept. 26, 1903. No. 57959.

Concentration.

Method of Concentrating at Anaconda. M. Schwerin. Describes the method, the object being to produce a concentrate with a greater percentage of copper and iron and less silica than the crude ore. 2000 w. Eng & Min Jour—Sept. 12, 1903. No. 57885.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Low-Grade Ore.

Leaching Low-Grade Copper Ore. Considers the successful treatment by the cost process when the ores are susceptible of leaching. 3500 w. Min & Sci Pr—Sept. 12, 1903. No. 57896.

Nevada.

The Ore Deposit at Contact, Nevada. Chester W. Purington. Abstract of a paper in the Pro. of the Colorado Sci. Soc., describing these copper bearing deposits. Ill. 2000 w. Eng & Min Jour—Sept. 19, 1903. No. 57941.

Smelting.

Pyritic Smelting. Franklin R. Carpenter. Trans. Am. Min. Cong., Deadwood, S. D. Describes a process of smelting applicable to any raw ores not carrying lead, but especially to sulphide ores carrying copper. 1100 w. Min & Sci Pr—Sept. 12, 1903. Serial. 1st part. No. 57895.

GOLD AND SILVER.

Bendigo.

The Synclinal or "Inverted Saddle" Reefs at the Bendigo Goldfields. Wm. H. Cundy, in *Trans. Aust. Inst. of Min. Engrs.* An illustrated article considering the formation, characteristics, etc. 2200 w. Can Min Rev—Aug. 31, 1903. No. 57753 B.

Black Hills.

Black Hills, South Dakota. Notes on mills and mill work, with illustrations. 3800 w. Min Rept—Sept. 3, 1903. No. 57736.

Ore Deposits of the Northern Black Hills. J. D. Irving. Trans. Amer. Min. Cong., Deadwood, S. D. (Condensed.) The present article deals principally with the geology of this region. 1000 w. Min & Sci Pr—Sept. 12, 1903. Serial. 1st part. No. 57894.

California.

Some Structural Features of the California Gold Belt. W. H. Storms. Illustration and description of these features of the section known as the Mother Lode. 1600 w. Min & Sci Pr—Aug. 22, 1903. Serial. 1st part. No. 57613.

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Concentration.

Two Notable Concentrating Plants. G. A. Burr. Illustrates and describes two plants within a quarter of a mile of each other, treating nearly identical ores with very different methods. The ores contain silver, gold, lead, zinc, iron, copper, and silica. 1200 w. Eng & Min Jour—Sept. 12, 1903. No. 57887.

Crushing.

A System of Crushing Rock in Stages by Wet Process and Suggestions as to How This Object Can Best Be Achieved. Edward D. Chester. A discussion of this paper taken as read. 1500 w. Jour Chem, Met & Min Soc of S Africa—July, 1903. No. 57709 E.

Cyaniding.

Cyanidation at the Kalgurli Mine, Kalgoorlie. Edwin O. Watt. Abstracted from the *Trans.* of the Australasian Inst. of Min. Engrs. Illustrates and describes the treatment of this ore. 2700 w. Eng & Min Jour—Aug. 29, 1903. No. 57631.

Cyaniding Methods at the Homestake Plant. C. W. Merrill. An interesting illustrated description of the actual practice. 4500 w. Pacific C Min—Aug. 29, 1903. No. 57733.

Deposits.

Bonanzas and Pockets of Ore. Prof. Arthur Lakes. Considers some of the causes of their deposition and origin as illustrated in various mines. Ill. 1800 w. Mines & Min—Sept., 1903. No. 57591 C.

Dredging.

Dredging at Oroville. Newton B. Knox. Abstract of a paper in the *Pro.* of the Inst. of Min. & Met., London. Brief account of the dredge-mining for gold in California. 900 w. Eng & Min Jour—Aug. 29, 1903. No. 57632.

Extraction.

A Modern Gold-Reduction Plant on the Witwatersrand Goldfield. Gives details of the extraction processes, with illustrations. 2000 w. N Z Mines Rec—July 16, 1903. No. 57832 B.

New Zealand.

The Gold Dredging Industry in New Zealand. William Wylie, in *Trans. Aust. Inst. of Min. Engrs.* Reviews the development of this industry, methods tried, and describes present practice. 4000 w. Can Min Rev—Aug. 31, 1903. No. 57754 B.

Ore Treatment.

Roasting and Filter-Press Treatment at Kalgoorlie. J. T. Marriner. Describes the treatment of these sulpho-telluride ores, and also the filter-press used, giving costs. 2700 w. Eng & Min Jour—Sept. 5, 1903. No. 57784.

Volatilization of Metals as Chlorides. Stuart Croasdale. Relates to the volatilization of metals as chlorides from their ores during a chloridizing roast. 4500 w. Eng & Min Jour—Aug. 29, 1903. No. 57629.

Placers.

The Problem of Dry-Placers. Henry A. Mather. Considers the difficulties of gold recovery and the means employed. 1200 w. Eng & Min Jour—Aug. 29, 1903. No. 57630.

Precipitation.

The Precipitation of Gold from Cyanide Solutions. W. A. Caldecott and E. H. Johnson. A discussion of the main features, with explanation of processes and methods, and suggestions for research. 4500 w. Jour Chem, Met & Min Soc of S Africa—July, 1903. No. 57708 E.

Pyrites.

Treatment of Pyrites Containing Combined Gold. An account of a new process being used for the treatment of auriferous arsenical pyrites of Piedmont, Italy, by a Belgian company. 800 w. Sci Am Sup—Sept. 26, 1903. No. 57961.

Transvaal.

The Future of the Transvaal (Le Transvaal et Son Avenir). Raphael-Georges Lévy. An exhaustive review of the mineral resources of the Transvaal, and of the prospects of their future development. 15000 w. Bull Soc d'Encour—July 31, 1903. No. 58041 G.

Witwatersrand.

Observations on the Metallurgical Practice of the Witwatersrand. H. S. Denny. Discusses the more important points in the treatment of gold ores; crushing, sorting, milling, amalgamation, concentration, classification of sands and slimes, cyaniding of sands, and cyaniding of slimes. Ill. 24000 w. Jour Chem, Met & Min Soc of S Africa—July, 1903 No. 57706 E.

IRON AND STEEL.

Baraboo District.

The Baraboo Iron District Mining Developments. A report of recent developments in Wisconsin. 2000 w. Ir Age—Sept. 17, 1903. No. 57870.

Castings.

See Mechanical Engineering, Machine Works and Foundries.

Crystallization.

Crystallization of Iron and Steel. William A. Doble's contribution to a discussion at the July meeting of the Pacific Coast Ry. Club, giving an account of the results of long and careful study.

7000 w. Ry Age—Sept. 4, 1903. No. 57747.

Electric Power.

See Electrical Engineering, Power Applications.

Furnace Explosions.

Explosions Caused by Obstructions in Blast Furnaces (Ueber die durch das Hängen der Gichten Veranlassten Hochofenexplosionen). Adalbert Nath. A discussion of the causes of gas explosions in blast furnaces, including the effects of increased temperatures upon dissociation of the gases. 1800 w. Stahl u Eisen—Aug. 15, 1903. No. 58029 D.

Iron Ore.

The Probability of Iron Ore Lying below the Sands of the Duddon Estuary. James Leslie Shaw. Gives some undoubted facts in support of the assumption that there are deposits of good quality and quantity, describing the faulting, and suggestions for exploration work. 2700 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57861 A.

Iron Trade.

See Industrial Economy.

Magnetite.

Magnetite Deposits at Mineville, N. Y. Heinrich Reis. Describes the ore bodies, and the new electric concentrating plant. Ill. 2000 w. Mines & Min—Sept., 1903. No. 57590 C.

Nickel Steel.

See Mechanical Engineering, Materials.

Pig Iron.

Buying Pig Iron on Specification. Herbert E. Field. Read at meeting of the Am. Found. Assn. Considers the specification and its use. 2400 w. Foundry—Sept., 1903. No. 57983.

Rails.

Notes on the Heat Treatment of Steel Rails High in Manganese. J. S. Lloyd. Read before the Ir. & Steel Inst. 900 w. Engng—Sept. 11, 1903. No. 57912 A.

Sorbitic Steel Rails. J. E. Stead and Arthur W. Richards. Read before the Iron & Steel Inst. Gives a description of experiments in making sorbitic rails, and their relative wear. 3500 w. Engng—Sept. 4, 1903. No. 57854 A.

Rolling Mills.

Evolution of the Rolling Mill. Extracts from an article by T. J. Brown, published in *Camp and Plant*. Describes the merchant steel department of the Minnequa works at Pueblo, Colo. Also sketches the evolution of the rolling of merchant steel in the United States. 5500 w. Ir Trd Rev—Aug. 27, 1903. No. 57589.

See Mechanical Engineering, Machine Works and Foundries.

Silicon.

The Influence of Silicon on Iron. Thomas Baker. An account of research, having for its object the preparation of a series of alloys of silicon and iron, and a study of the microstructure, mechanical and physical properties. 2700 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57862 A.

Steel.

Diseases of Steel. C. H. Ridsdale Read before the Iron & Steel Inst. Considers faults originating during manufacture, traced forward; and faults manifested, and traced backward. The prevention and cure. 16500 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57859 A.

Some Elements Used in Steel-Making. Considers the influence on steel of tungsten, molybdenum, vanadium, and uranium. 2500 w. Engr, Lond—Sept. 18, 1903. No. 58106 A.

The Burning and Overheating of Steel. Alfred Stansfield. A study of the conditions under which the steel becomes "burnt," the nature of this so-called "burning," and the way it can be rendered suitable for use. 5200 w. Ir & Coal Trds Rev—Sept. 4, 1903. No. 57864 A.

The Restoration of a Dangerously Crystalline Steel by Heat Treatment. J. E. Stead and Arthur W. Richards. Read before the Iron & Steel Inst. An account of the authors' work in studying the effect of heat on the mechanical properties of steel. 5000 w. Engng—Sept. 4, 1903. No. 57856 A.

Steel Production.

Steel Production Three Decades Ago and To-day. Andrew Carnegie. Presidential address, delivered before the Iron and Steel Inst., at Barrow-in-Furness, England. 1800 w. Eng News—Sept. 10, 1903. No. 57824.

Swedish Lapland.

Iron Ores of Arctic Lapland. Chase S. Osborn. A report of these iron-ore fields, located beyond the Arctic circle, the character of the ores, methods of mining, etc. 1800 w. Ir & Coal Trds Rev—Sept. 11, 1903. No. 57917 A.

MINING.

Accidents.

Fatal Accidents in Coal Mines in North America, 1902. Frederick L. Hoffman. Statistics showing a decided increase in the fatal accidents. 1000 w. Eng & Min Jour—Sept. 5, 1903. No. 57783.

Borneo.

Mining in Dutch West Borneo. M. W. von Bernewitz. Gives important points of mining laws, with comments. 2000 w.

Aust Min Stand—Aug. 13, 1903. No. 57834 B.

Drying.

The Mechanical Drying of Minerals. C. O. Bartlett. Read at Mining Congress, Deadwood. Considers products of value now coming into use and the treatment they require. Especially considers Portland cement, and methods of drying minerals. 2000 w. Min Rept—Sept. 17, 1903 No. 57921.

Electric Drills.

Electric Rock-Drills. E. J. Munby. A discussion of the application of electricity to drilling, showing its utility, economy, etc. 1800 w. Stevens Ind—July, 1903. No. 57680 D.

Electric Power.

See Electrical Engineering, Power Applications.

New Mexico.

The Geology of the Cerrillos Hills, New Mexico. Douglas Wilson Johnson. Aims to give a fairly complete account of the geology of this district. Ill. 16500 w. Sch of Mines Qr—April, 1903. Serial. 1st part. No. 57971 D.

Shaft Sinking.

The Latest Progessive Shaft Sinking Chief Engineer Riemer. Translated from the "Report of the Eighth General German Mining Congress at Dortmund." A discussion of the advances that have been made. Ill. 14000 w. Sch of Mines Qr. No. 57972 D.

Timbering.

Systematic Timbering: Report of the Prussian Commission on Falls of Roof and Coal. Abstract from this report, dealing with general observations on timbering in the different countries visited. Ill. 2800 w. Col Guard—Aug. 28, 1903. No. 57717 A.

Valuation.

Cost per Ton as a Basis of Mine Valuation. R. Gilman Brown. Considers the method of determining the cost per ton. 2000 w. Eng & Min Jour—Aug. 29, 1903. No. 57628.

Ventilation.

The Ventilation of Deep Levels. Thomas Johnson. Considers means of securing efficient ventilation. Ill. 6000 w. Jour Chem, Met & Min Soc of S Africa—July, 1903. No. 57707 E.

Winding.

Traversing Winding Engine for Deep Shafts. H. M. Morgans. Illustrates and describes a plant which avoids many of the difficulties of deep winding. 4000 w. Mines & Min—Sept., 1903. No. 57593 C.

Wolfram Camp.

Wolfram, Molybdenite, and Bismuth Mining, at Wolfram Camp, Hodgkinson Goldfield. Walter E. Cameron. Deals with the geology, working, etc. 3500 w. Queens Gov Min Jour—July 15, 1903. No. 57700 B.

MISCELLANY.

Arsenic.

A Rapid Method for the Determination of Arsenic in Arsenopyrite. J. L. Danziger and W. H. Buckhout. Results of a series of experiments are given. 1600 w. Sch of Mines Qr—April, 1903. No. 57973 D.

Diamonds.

Diamond Mining in the Kimberley Field. Charles V. Allen. An illustrated account of the modern methods employed in working the diamond mines of South Africa. 4000 w. Engineering Magazine —Oct., 1903. No. 58087 B.

The Diamond District of the Vaal River. T. Lane Carter. A description of the methods of working, and of the deposits. Ill. 1400 w. Eng & Min Jour —Sept. 5, 1903. No. 57785.

Gypsum.

The Gypsum of the Eden Valley. David Burns. Read before the Inst. of Min. Engrs. at Keswick. An account of these mines, describing the deposits and discussing their origin. Brief general discussion. 5000 w. Quarry—Sept., 1903 No. 57794 A.

Manganese.

A study of Manganese Steel (Recherches sur les Aciers au Manganese). Leon Guillet. A study of the properties of manganese steel, making use of the methods of metallography. Two articles. 4000 w. Génie Civil—Aug. 22, 29, 1903 No. 58001 each D.

Metallography.

See Mechanical Engineering, Materials.

Minerals.

Cutting and Polishing Mineral Specimens. Prof. Frank W. Brady. Gives a method of constructing apparatus at a small cost by which specimens may be prepared for exhibit or use. Ill. 1500 w. Mines & Min—Sept., 1903. No. 57594 C.

Petroleum.

Petroleum in California. Edmond O'Neill, in *Jour. Am. Chem. Soc.* Information concerning the deposits, quality, use, character, etc. 4000 w. Am Gas Lgt Jour—Sept. 7, 1903. No. 57744.

The Oil Industry of California from a Commercial Standpoint. Dr. C. T. Deane. Read before the Pacific Coast Gas Assn. Gives some information in regard to oil wells, cost of sinking, production, consumption, etc., showing the commercial value. 4000 w. Am Gas Lgt Jour—Aug. 31, 1903. No. 57598.

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Separation.

Magnetic Separation of Tin and Wolfram at Gunnislake Clitters. Edward Skewes. Describes the work accomplished by a magnetic separator having a capacity of about 5 tons per day. 700 w. Eng & Min Jour—Sept. 19, 1903. No. 57940.

Zinc.

The Electro-Metallurgy of Zinc (Electro-Métallurgie du Zinc). A. Salguès. A description of the electric furnace and process for the smelting of zinc in operation at Crampagua, Ariège, France. 9000 w. Mem Soc Ing Civ de France—July, 1903. No. 58028 G.

RAILWAY ENGINEERING

MOTIVE POWER AND EQUIPMENT.

Brakes.

The Combined Straight Air and Automatic Engine and Tender Brake. Extracts from a paper before the Traveling Engrs. Assn., by Frank P. Roesch. Some points in braking, discussing changes made necessary by new conditions, and setting forth the advantages of the brake named. 1000 w. R R Gaz—Sept. 18, 1903. No. 57949.

Cars.

Best Method of Painting and Maintaining Steel Cars. Two papers, by J. D. Wright, and W. O. Quest, read before the Master Car & Soc. Paint. Assn. On the best protective coatings, way of applying, etc. 3800 w. Ry Age—Sept. 11, 1903. No. 57877.

Box Car with Strong End Construction, for the Central Railroad of New Jersey. Illustrated description. 1000 w. Loc Engng—Sept., 1903. No. 57739 C.

Car of 50 Tons Capacity in Pressed Steel (Wagon de 50 Tonnes en Tole d'Acier Embontie). Ch. Dantin. Illustrated description of 50-ton pressed-steel coal car of French manufacture. 1000 w. Génie Civil—Sept. 12, 1903. No. 50009 D.

Distributed Cost of Car Repairs. Gives a table showing the results of a carefully kept record in an important trunk line for the year 1902. 350 w. Am Engr & R R Jour—Sept., 1903. No. 57657 C.

Private Owners' Wagons. Revised specifications and drawings issued by the Railway Clearing House Committee of England. 2300 w. Col Guard—Aug. 28, 1903. No. 57716 A.

Steel-Frame Side-Door Passenger Car—Illinois Central R. R. Illustrated detailed description, with discussion of the design. 2 plates. 2800 w. Ry Age—Sept. 4, 1903. No. 57746.

Couplings.

Automatic Couplings for Railway Rolling Stock. Ernst Sauer. Abstract from *Glaser's Annalen*. Discusses the adaptability of the American Master Car Builders' couplers in connection with the German screw couplers. Ill. 5500 w. Bul Internat Ry Cong—Aug., 1903. No. 57-814 E.

Fire-Box Stays.

Locomotive Fire-Box Stays. Francis William Webb. An illustrated description of a number of trials made, with conclusions. Also a summary of the discussion. 5000 w. Bul Internat Ry Cong—Aug., 1903. Serial. 1st part. No. 57812 E.

Locomotive Boilers.

Special Features in the Design of Locomotive Boilers and Fireboxes. Charles S. Lake. Discussing the efforts to increase the steaming efficiency of the boiler to meet the increased demands for hauling power and speed. The first of two articles. 3500 w. Engineering Magazine—Oct., 1903. No. 58085 B.

The Care of Locomotive Boilers. M. E. Wells. Second prize paper of the Pacific Coast Ry. Club. Details of care needed. 5000 w. Ry Age—Sept. 11, 1903. No. 57876.

Locomotives.

Care and Handling of the Compound Locomotive. A. L. Beardsley. Abstract of a paper before the Traveling Engrs.' Con. Suggestions helpful in obtaining good results, with mention of some things to be avoided. 2500 w. R R Gaz—Sept. 18, 1903. No. 57948.

Compound Locomotive with Superheater. Illustrates and describes a locomotive of the 4-6-0 type, equipped with the Schmidt system of superheating—Canadian Pacific Ry. 1100 w. Am Engr & R R Jour—Sept., 1903. No. 57656 C.

Four-Cylinder Compound Locomotive for the Jura-Simplon Railways. Illustrated detailed description. 1000 w. Engng—Aug. 28, 1903. No. 57726 A.

Mallet Articulated Locomotive for the Baltimore & Ohio. Elevation view and brief description of an engine having a frame hinged in the middle to allow of horizontal swing. 600 w. Ry Age—Sept. 4, 1903. No. 57748.

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Narrow-Gauge Locomotives (Les Locomotives à Voie Etroite). H. Martin. With diagrams and data of a number of recently-constructed engines. Serial. Part 1. 2000 w. Genie Civil—Sept. 12, 1903 No. 58008 D.

Northern Pacific Consolidation Locomotive. Illustrated description of a heavy engine for freight service. 700 w. Ry Age—Aug. 28, 1903. No. 57599.

Oil--Burning Passenger Locomotive. Illustrated description of a Vauclain compound 4-4-2 type, for the Southern Pacific Ry. 300 w. Am Engr & R R Jour—Sept., 1903. No. 57658 C.

Saddle Tank Switching Locomotive. An illustrated description of the application of a wide firebox to a saddle tank switcher. 300 w. Ry Mas Mech—Sept., 1903. No. 57732.

Santa Fe Four-Cylinder Balanced Compound. Illustration, plan, cross sections, and detailed description. 1400 w. Ry Age—Sept. 18, 1903. No. 57923.

The New Caledonian Giants at Work. Charles Rous-Martin. On the performance of recently built engines for the Caledonian Railway. 3000 w. Engr, Lond—Aug. 21, 1903. No. 57586 A.

Rack Locomotives.

A Critical Description of Recent Rack Locomotives for Mixed Service (Kritische Beschreibung der bis jetzt Gebauten Zahnradlokomotiven für Gemischen Betrieb). A. Werner. A tabulated account of the various types of locomotives in use for rack railways on mountain inclines. Serial. Part I. 4000 w. Glasers Annalen—Aug. 15, 1903. No. 58021 D.

Shoes.

Lining of Shoes and Wedges. W. D. Chamberlin. Reproduced from the issue of Feb., 1900. An illustrated explanation of method recommended. 2800 w. Loc Engng—Sept., 1903. No. 57738 C.

Train Lighting.

Axle Lighting. Elmer A. Sperry. Discusses the advantages of electricity for car lighting, the progress, and the system of the future, announcing a new system of axle-lighting, with regulating devices. 3000 w. St Louis Ry Club—Aug. 14, 1903. No. 57795.

Electric Lights on Railway Trains in Germany and Austria. Illustrations with brief notes on the Dick system. 600 w. U S Cons Repts, No. 1740—Sept. 3, 1903. No. 57679 D.

The Lighting of Railway Carriages (Eclairage des Voitures de Chemins de Fer). An illustrated account of the successful use of incandescent gas mantles for lighting railway trains in France. 2000 w. Génie Civil—Aug. 22, 1903. No. 58003 D.

Train-Lighting on the Eastern Railway of France. An account of the difficulties met in using the system of incandescent gas-lighting, and the final type of lamp and burner adopted. Ill. 2500 w. Engng—Sept. 18, 1903. No. 58101 A.

Wheels.

Defects of Cast Iron Wheels and How to Inspect for Them. W. A. Mitchell. Suggestions helpful to inspectors. 2000 w. Loc Engng—Sept., 1903. No. 57737 C.

NEW PROJECTS.

Bagdad Railway.

The Bagdad Railway. Map and account of the projected railway, recalling the history of the region through which it passes, the ancient system of irrigation, and the disaster that destroyed these works, the possibility of reconstructing them, cost, etc. 3700 w. Engng—Sept. 18, 1903. No. 58100 A.

Simplon.

Connections to the Simplon Railway (Simplon et Faucille). Louis Lafitte. A discussion of the relation of the Simplon tunnel to the French railways, advocating a short connection of the Paris, Lyons & Mediterranean railway to the Jura-Simplon line by way of the Col de la Faucille. Two articles. 8000 w. Génie Civil—Aug. 29, Sept. 5, 1903. No. 58005 each D.

PERMANENT WAY AND BUILDINGS.

Ballast.

Ballast for Railways. Considers the kinds of ballast used and the value of each. 3000 w. Engr, Lond—Aug. 28, 1903. No. 57719 A.

Construction.

Construction Work on the Pennsylvania R. R. between Harrisburg and Gallitzin. An illustrated description of the work in progress, the methods employed, certain details of construction, and cost. 4400 w. Eng News—Sept. 24, 1903. No. 57957.

Cut-Off.

The Leamington Cut-Off of the Oregon Short Line R. R. in Western Utah. W. P. Hardesty. An illustrated detailed description of this important work. 5300 w. Eng News—Sept. 17, 1903. No. 57946.

Improvements.

The Illinois Central Improvements—New Lines and Second Track. An illustrated account of new lines, with a statement of the purpose they are to serve, and of second track work in progress. 2000 w. R R Gaz—Aug. 28, 1903. No. 57638.

Oklahoma.

Some Railway Construction in Oklahoma. A. G. Allan. An illustrated account

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of construction work on a line being built by the A., T. & S. F. Ry. from Newkirk, Ok., to Pauls Valley, Ind. Ter. 2000 w. Pro Am Soc of Civ Engrs—Aug., 1903. No. 57683 E.

Power Plant.

Power Plant of the Rock Island-Lake Shore Terminal Station, Chicago. Illustrates and describes the power plant which serves the station and terminal yards, furnishing electricity for power, lighting, switching and elevator service; compressed air for various uses; steam for heating, and water needed. 2400 w. Eng Rec—Sept. 19, 1903. No. 57932.

Reconstruction.

Baltimore & Ohio's Reconstruction. An account of the comprehensive improvements in progress in both roadbed and equipment. 2600 w. Ry Age—Sept. 18, 1903. No. 57922.

Shops.

New Locomotive Shops of the Chicago, St. Paul, Minneapolis & Omaha at Sioux City. Illustrated detailed description. 2400 w. R R Gaz—Sept. 11, 1903. No. 57830.

Signalling.

Automatic Block Signals for Railroads. Ralph Scott. An illustrated article explaining the general practice. 4500 w. Am Elect'n—Sept., 1903. No. 57779.

Stations.

Cupples Station—A Combined Freight Depot and Business Block. Earl Mayo. A description of this remarkable station in St. Louis, for handling, distributing and trans-shipment of goods. 1400 w. Sci Am—Aug. 29, 1903. No. 57614.

Connecting Stations Between Railways and Waterways (Des Gares de Raccordement entre Chemins de Fer et Voies Navigables). M. Mazoyer. Describing the railway connections of the canals of Roanne, the Loire, and the Nivernaise, illustrating the stations at the points of junction. 7000 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1903. No. 58045 E + F.

The Rock Island Terminal Station, Chicago, Ill. An illustrated detailed description of a large station. 3400 w. Eng Rec—Sept. 12, 1903. No. 57881.

Ties.

A Review of the Railway Tie Question. Editorial discussion of the present condition and future prospects in regard to wooden ties, and brief review of other materials used. 3000 w. Eng News—Sept. 10, 1903. No. 57822.

Railway Ties and Tie Plantations in Mexico and South Africa. Gives information relative to the experience of two counties which have not a sufficient supply of suitable timber for ties. 2500 w. Eng News—Sept. 10, 1903. No. 57823.

The Ayer & Lord Tie Co.'s Carbondale Preserving Plant. An illustrated detailed description of this Illinois plant, remarkable for its size, structures and arrangements for all the successful processes of preserving timber. 1600 w. R R Gaz—Sept. 11, 1903. No. 57825.

The Operation of the Burlington Tie Treating Plant. F. J. Angier. Illustrated detailed description of the plant at Sheridan, Wyo. 2500 w. Ry Age—Sept. 4, 1903. No. 57745.

TRAFFIC.

Earnings.

Disproportion of Gross and Net Railroad Earnings. Editorial discussion of the returns as published by the *Financial Chronicle*. 1200 w. Ir Age—Sept. 10, 1903. No. 57768.

Tonnage.

The Proper Handling of the Tonnage Rating System. R. S. Wickersham. Discusses points that are important in making tonnage rating a success. 1500 w. Am Engr & R R Jour—Sept., 1903. No. 57660 C.

MISCELLANY.

Crewe.

The Railway Town of Crewe. Charles S. Lake. An illustrated article reviewing the development of the home of the London & North-Western Railway works, describing the shops, which are the largest in the world. 5400 w. Cassier's Mag—Sept., 1903. No. 57937 B.

Ireland.

Some Early Irish Railroads. W. B. Paley. Brief historical review. 1500 w. R R Gaz—Sept. 11, 1903. No. 57826.

STREET AND ELECTRIC RAILWAYS

Accounting.

Census Statistics and the Standard form of Electric Railway Accounting. William M. Steuart. A discussion of the difficulties attending a uniform application of a system of accounts. 8000 w. St Ry Rev (Daily Ed)—Sept. 4, 1903. No. 57802 C.

Purchasing and Accounting for Supplies on Electric Railway Systems. W. H.

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Staub. Explains the system used by the United Railways & Electric Co. of Baltimore, Md. 2800 w. St Ry Rev—Aug. 21, 1903. No. 57622 C.

Albany.

United Traction System of Albany. An illustrated description of the line, its equipment and management. 4800 w. St. Ry Jour—Aug. 29, 1903. No. 57669 D.

Car Bodies.

Care and Maintenance of Car Bodies. C. F. Baker. The writer's views from experience in meeting the conditions at Boston. General discussion. 9500 w. St Ry Rev (Daily Ed)—Sept. 2, 1903. No. 57799 C.

Car Houses.

The Application of Mill Construction to Car Houses. J. O. DeWolf. An illustrated detailed description of this construction, showing its advantages. 1800 w. St Ry Rev—Aug. 20. 1903. No. 57621 C

Claim Department.

I. The Machinery of the Claim Adjusting Department. T. E. Mitten. Describes in detail the method of reporting accidents and adjusting claims in vogue on the system of the International Ry. Co. of Buffalo. II. The Successful and the Unsuccessful Claim Agent. Dr. H. B. Rockwell. Analyzes the qualifications necessary. 4700 w. St Ry Rev—Aug. 20, 1903. No. 57620 C.

Controllers.

The Use and Abuse of Controlling Mechanism. D. F. Carver. On the importance of watchfulness, care and systematic inspection. General discussion. 4500 w. St Ry Rev (Daily Ed)—Sept. 4, 1903. No. 57805 C.

"Type M" Control. W. O. Mundy. Brief description, with remarks on the uses of this controller and its advantages. Short discussion. 2400 w. St Ry Rev (Daily Ed)—Sept. 3, 1903. No. 57801 C.

Direct Currents.

The Transmission of a 23,000-Volt Direct Current Over a Distance of Thirty-five Miles. Emile Guarini. Illustrates and describes the hydro-electric plant at St. Maurice, near Lausanne, Switzerland. 1800 w. Sci Am Sup—Aug. 29, 1903. No. 57617.

Economics.

Possible Economies in Central Station and Distribution Systems. Philip Dawson. A résumé of current practice in power station operation, discussing the problem of economical production and distribution of electrical energy. 4500 w. St Ry Jour—Aug. 29, 1903. No. 57676 D.

Electric Traction.

Electric Traction on Railways. Br. Bohm-Raffay. From *Zeitschrift des Ingenieur- und Architekten Vereines.* Describes briefly the experimental roads in Germany and Switzerland, for the running at high speeds, giving details of the system adopted by the Maschinenfabrik Oerlikon. 4600 w. Bul Internat Ry Cong—Aug., 1903. No. 57813 E.

English Tramways.

Lowestoft Municipal Electric Tramways. Illustrated detailed description. 3000 w. Tram & Ry Wld—Sept. 3, 1903. No. 57846 B.

Reading Corporation Electric Tramway. Illustrated detailed description of this road and its equipment. 10800 w. Tram & Ry Wld—Sept. 3, 1903. No. 57845 B.

Feeder Calculations.

Feeder Calculations for Direct Current Railways. William A. Del Mar. Considers four typical cases which show the most important distributions of copper and current. 2800 w. Elec Wld & Engr—Aug. 29, 1903. No. 57605.

Gasolene.

Gasolene Cars for Interurban Service. Illustrates and describes a gasolene car put in service in Iowa. 2000 w. St Ry Jour—Sept. 19, 1903. No. 57927 C.

Goods Traffic.

Carriage of Goods on Electric Tramways. Alfred H. Gibbings. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. Shows the possibility of cheapening the cost of conveyance by utilizing electric tramways for short distance traffic. 4400 w. Elect'n, Lond—Aug. 21, 1903. No. 57579 A.

Freight and Express on Electric Railways. J. B. McClary. Considers methods of handling freight and express on electric roads, the profits, and related matter of interest. 4800 w. St Ry Jour—Sept. 12, 1903. No. 57888 C.

Interurban.

Fonda, Johnstown and Gloversville system. Illustrates and describes this system which combines both steam and electric operation. 7000 w. St Ry Jour—Aug. 27, 1903. No. 57670 D.

The City and Interurban System of the Schenectady Railway Company. An illustrated survey of this system which has features of more than ordinary interest. 3000 w. Elec Rev, N Y—No. 57601.

The Electric Division of the Fonda, Johnstown & Gloversville Railroad. H. O. Rockwell. Illustrates and describes the line and its equipment. 10000 w. St Ry Rev—Aug. 20, 1903. No. 57625 C.

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The Hudson Valley Railway. An illustrated article describing this system and its points of interest. 3800 w. St Ry Jour—Aug. 29, 1903. No. 57668 D.

The West Penn Railways and Lighting System. An illustrated detailed description. 7800 w. St Ry Jour—Sept. 5, 1903. No. 57808 C.

Intramural Railway.

The Intramural Railway for the St. Louis World's Fair. Two illustrated articles by Richard H. Phillips, and by Charles V. Weston. The first is descriptive; the second discusses the original design, with estimates on performance and cost. 3300 w. St Ry Rev—Aug. 20, 1903. No. 57618 C.

London.

London United Electric Tramways. B. Pontifex. An illustrated detailed description of the power-house equipments, and the cars and overhead construction work, etc. 3300 w. Elec Engr, Lond—Aug. 21, 1903. No. 57572 A.

The Central London Railway. H. F. Parshall, E. Parry, and W. Casson. The present article gives an illustrated detailed description of the later type of motor cars which are now in service. 1700 w. Trac & Trans—Sept., 1903. Serial. No. 57852 E.

The Question of Tramways for London. W. Craig Henderson. Considers the traffic conditions of Central London and thinks the narrowness of the streets makes rapid tramway communication in that part of the city impracticable. 5000 w. Trac & Trans—Sept., 1903. No. 57847 E.

Massachusetts.

Expansion of Electric Railways in Massachusetts. Alton D. Adams. A review of the returns for 1901, showing the remarkable development. 1500 w. Sci Am—Sept. 19, 1903. No. 57889.

New South Wales.

Electric Traction in Sydney, New South Wales. Arthur C. W. Webb. An illustrated detailed description. 3300 w. Elec Wld & Engr—Aug. 29, 1903. No. 57602.

New System.

Tangential Traction. An explanation of a new system of electric traction invented by two young Russian engineers, and based upon the direct application of polyphase currents. 2400 w. Elec Rev, Lond—Aug. 21, 1903. Serial. 1st part. No. 57575 A.

New York City.

Report of the Merchants' Association on Improving the Surface Car Service of New York City. Abstracts such features of the report as are of general interest 6000 w. Eng News—Sept. 17, 1903. No. 57947.

Report of the New York Rapid Transit Commissioners. An illustrated review of the second report of the Board, for the year ending Dec. 31, 1902. 4000 w. R R Gaz—Sept. 4, 1903. No. 57791.

Section Seven, Division Three, of the New York Rapid Transit Railroad. An illustrated description of the work on this section almost wholly in tunnel excavation through micacous rock, and having dufficulties due to the irregularity of the ground and obstructions at various points. 4200 w. Eng Rec—Sept. 19, 1901. No. 57935.

Overhead Construction.

Standard Overhead Construction in City Streets. An illustrated outline of the practice in the largest cities of the United States, with general conclusions. 2700 w. St Ry Jour—Aug. 29, 1903. No. 57673 D.

Paris Underground.

The Metropolitan Underground Railway of Paris. Illustrates and describes the construction of the North Circle. 3000 w. Eng News—Sept. 3, 1903. No. 57790

Power Equipment.

Power Equipment for City Roads. An illustrated article, showing the general condition of power equipment of American cities. 3200 w. St Ry Jour—Aug. 27, 1903. No. 57675 D.

Remittances.

The Advantages and Disadvantages of the "Bag System," as Compared with the "Receiver System" of Handling Conductor's Remittances. Frank R. Henry. Considers the comparative advantages and disadvantages of the two systems. 4400 w. St Ry (Daily Ed)—Sept. 4, 1903. No 57803 C.

Repair Shop.

Modern Repair Shop Methods. Richard McCulloch. An illustrated description of the equipment, operation and methods of the repair shop of the Chicago City Ry. and giving much valuable information. 4800 w. St Ry Jour—Aug. 29, 1903. No. 57677 D.

Rolling Stock.

Standard Practice in Rolling Stock for City Service. Illustrates and describes the types of cars, showing the tendency to increase the length and weight, and the growing popularity of the semi-convertible car. 6500 w. St Ry Jour—Aug. 29, 1903. No. 57674 D.

Running Powers.

Running Powers Over Tramways. Vincent R. Balfour-Browne. Discusses cases in England where running powers have been granted to one company to run over and use the stations of another company. 3000 w. Trac & Trans—Sept., 1903. No 57848 E.

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Schenectady.

Schenectady's City, Suburban and Interurban Electric Railway Facilities. An illustrated description of rapid advancement in the electric railway industry. 5800 w. St Ry Jour—Aug. 29, 1903. No. 57671 D.

Shops.

Shop Practice. Alfred Green. The writer's experience, describing the plant of the Rochester Ry. Co. and the practices in vogue. Ill. 8500 w. St Ry Rev (Daily Ed)—Sept. 3, 1903. No. 57800 C.

Signaling.

Automatic Electric Railway Signaling; Its Purposes; Also Past and Present Installations. C. C. Rosenberg, and H. S. Balliet. Shows the method of installation and apparatus from the inception of automatic signaling, the improvements made, etc. 8000 w. Jour Fr Inst—Sept., 1903. No. 57974 D.

Single-Phase.

A New Single-Phase System of Electric Traction. Brief illustrated description of the Westinghouse installation for the Baltimore, Washington & Annapolis Electric Ry. 2000 w. St Ry Rev—Aug. 20, 1903 No. 57619 C.

Surface Contact.

Electric Traction by the Schuckert System of Superficial Contacts. Emile Guarini. Brief illustrated description, with statement of advantages claimed. 500 w. Sci Am Sup—Sept. 26, 1903. No. 57962.

Schuckert Surface-Contact Street Railway System. S. N. Taylor. An illustrated description of an experimental street railway, known as the "Contact Knob" system. 1200 w. Elec Wld & Engr—Aug. 29, 1903. No. 57603.

Surface Contact Systems on the Paris Traction Lines. C. L. Durand. Illustrates and describes two of the leading systems. 3500 w. Elec Rev, N. Y.—Sept. 5, 1903. No. 57759.

The Slot-Conduit System and the Schuckert Surface-Contact System. A comparison of working expenses of the Brussels and Paris slot-conduit systems, with the surface-contact system named, to the advantage of the latter. 3500 w. Elec Engr, Lond—Aug. 21, 1903. No. 57573 A.

Sweden.

The Adoption of Electric Traction on the Swedish State Railways. R. Dahlander. Abstract of a report made to determine whether electric traction was advisable under the conditions existing, and the limited traffic. 5300 w. Bul Internat Ry Cong—Aug., 1903. No. 57811 E.

Third Rail.

The Third-Rail System. L. E. Gould. Discusses details of the system. 3000 w. St Ry Rev—Aug. 20, 1903. No. 57623 C.

Third Rail System of the Albany & Hudson Railroad Co. R. P. Leavitt. Brief illustrated description of this line which carries passengers and freight between Albany and Hudson. 2000 w. St Ry Rev—Aug. 20, 1903. No. 57626 C.

Toledo.

The Toledo Railway and Terminal Company. Map and illustrated description of the lines and equipment of this company. 1800 w. Ry Age—Sept. 11, 1903. No. 57875.

Tracks.

Standard Practice in City Track Construction. An illustrated article outlining the standard practice of the largest cities in the United States. 7200 w. St Ry Jour—Aug. 29, 1903. No. 57672 D.

Trolley Omnibuses.

Electric-Trolley Omnibuses. Illustrated description of the most recent designs and their equipment. 1000 w. Elect'n, Lond—Aug. 21, 1903. No. 57578 A.

Electric Trolley Vehicles without Rails. Emile Guarini. An illustrated account of the application of trolley traction to ordinary highways, and its adaptability to lines of light traffic density. 4000 w. Engineering Magazine—Oct., 1903. No. 58083 B.

Overhead Traction for Road Vehicles. An illustrated description of the Stoll electric omnibus system. 1600 w. Elec Rev, Lond—Sept. 11, 1903. No. 57902 A.

The Lombard-Gerin Trolley Omnibus. Illustrates and describes briefly a type where the connection between the car and overhead wires is by a flexible cable. 1500 w. Elec Times—Sept. 10, 1903. No. 57874 A.

Trackless Tramways (Ueber Gleislose Bahnen). Max Stobrawa. A discussion of the commercial possibilities of electric traction without rails, using the overhead trolley and motor omnibuses upon ordinary highways. 6000 w. Elektrotech Zeitschr—Aug. 27, 1903. No. 58063 B.

Trolley Wire.

The Overhead Conductor of the Hagen Tramways (Die Profildraht Oberleitungsanlage der Hagener Strassenbahn). H. Welter. Describing the use of trolley wire of the hour glass section, including the method of supporting and operating with the bow trolley. 1800 w. Elektrotech Zeitschr—Aug. 13, 1903. No. 58054 B.

We supply copies of these articles. See page 315.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeft Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Alloys.

Iron, Steel, and Other Alloys. By Henry Marion Howe, Professor of Metallurgy in Columbia University in the City of New York. Size 9 by 6 in.; pp. xviii, 457; plates and illustrations in the text. Price, $5.00. Boston: Sauveur & Whiting.

The high authority which is associated with the writings of Professor Howe renders this latest work upon his especial subject one of much value. At the present time the older views as to the nature of the various forms of iron and steel are being modified by the revelations of the study of the physical character by the methods of metallography, and to-day the microscope and the photographic camera have become the working tools of the metallurgist. The present book was originally prepared for the use of students, supplementing instruction by lectures and other reading, but it has been extended beyond these limits by being made to include an account of the solution theory, by which it is sought to explain the facts revealed by the methods of metallography. Taking up first the analogy of metals and alloys to rocks, when examined under the microscope, the nature of solid solutions and their resemblance to liquid solutions is discussed, and the study of cooling and freezing curves taken up. This is followed by a discussion of binary alloys, either as forming no definite chemical compounds, or as combining chemically as well as forming solutions. The relation of electrical conductivity to physical constitution, as well as the other properties of the series of alloys, follow, all this forming really an introduction to the study of iron and steel considered as alloys composed of several constituents. The application of the methods of metallography to the study of these combinations and solutions are very fully discussed, and numerous illustrations from microphotographs are given, together with their interpretation. As a consequence of this theoretical study of the facts determined from the examination of the iron-carbon alloys which form what we know as steel and iron, there follows a practical discussion of the processes of affecting the properties of those alloys by the influence of heat, and the important subject of the heat-treatment of steel forms one of the most valuable portions of the work to the engineer. A knowledge of the reasons why the structure of a steel can be controlled by heat-treatment must influence to a marked degree the operations involved in processes of manufacture and working, and there is every reason to believe that the period of empiricism in this fundamental subject has passed, to be replaced by an intelligent application of determinate scientific principles. The so-called "phase rule," by means of which the probable stability of an alloy may be discovered, is clearly explained, and the work concludes with chapters upon the practical manufacture of iron and steel, including a study of blast furnaces, steel furnaces, and gas producers.

Book-Keeping.

The Science of Loose-Leaf Book-Keeping and Accounting. By Chas. A. Sweetland, Public Accountant. 7¾ by 5½ in.; pp. 238; forms, 48. Price, $2. St. Louis: Chas. A. Sweetland.

Loose-leaf book-keeping is a natural outgrowth of card indexing, and, like the latter, has developed rapidly within recent years. Its great advantages cannot fail to be recognized by an unprejudiced mind, and it is sure to supplant, in a large measure, the older methods of keeping records in permanently bound books. It is now generally understood that the term "loose leaf," as applied to book-keeping, or the keeping of records of any kind, means the use of books in which leaves may be inserted and from which leaves may be removed with entire freedom, as distinguished from bound books in which the leaves are permanently fixed. Flexibility, elasticity, economy of book space, saving of time, preservation of all old accounts with complete ease of reference, combined with the convenient handling of current accounts unencumbered with dead matter, are some of the advantages of the loose-leaf system, the knowledge of which is fast increasing, but is not yet as widespread as it should be, partly owing to the lack, heretofore, of a work dealing with

the whole subject. The volume under consideration presents the matter in convenient and convincing form, and treats the subject of loose-leaf book-keeping with the authority of a trained and experienced accountant, entirely conversant with the old as well as the new methods. Any one interested in accounting will be well repaid by a perusal of this book, for it will not only enlighten those who are still keeping books in the old way, but will also show the users of new methods how to derive the utmost benefit from the loose-leaf system.

Electric Railways.

Engineering Preliminaries for an Interurban Electric Railway. By Ernest Gonzenbach. Size, 9 by 6 in.; pp. 71; figures, 6. Price, $1. New York: McGraw Publishing Company.

The extension of interurban electric railways has gone on at such a rate that standardization in their design and construction has not had time to become fixed, and the roads now in operation exhibit all degrees of practice from that of horse-car lines to that of first-class steam railways. A systematic analysis of the conditions of a particular case, and an account of the methods proposed to meet those conditions, are, therefore, of great practical interest, and are given in the present volume, which is an amplification of a report on a projected railway in the middle west of the United States, this railway being a good example of some roads already built and many more still on paper. The plans for this road are discussed from both financial and engineering standpoints, and practical reasons are given for the designs recommended, the style of the book being so direct and clear that it appeals no less to the railway promoter than to the engineer.

Marine Engines.

Detail Drawings of a Four-Furnace Single-End Scotch Boiler, together with Diagrammatic Pipe and Auxiliary Plan Used in Connection with a Triple-Expansion Engine, and a 1,250-H. P. Triple-Expansion Engine, with Key Naming and Describing Every Part of the Engine. Three sheets of drawings and explanatory text. Price, $1. New York: Marine Engineering.

In issuing these reprints from *Marine Engineering*, the publishers have put some valuable information in convenient and accessible form where it will prove very useful to the marine-engine designer and to the student of marine engineering. The sheets of drawings come in a neat cover and are accompanied by two pages of text describing the standard forms of marine steam plants, and containing a key to the diagrammatic pipe plan.

Mechanical Engineer's Pocket-Book.

The Mechanical Engineer's Pocket-Book of Tables, Formulæ, Rules and Data. A Handy Book of Reference for Daily Use in Engineering Practice. By the late D. Kinnear Clark, M. Inst. C. E. Fifth Edition, Revised Throughout and Enlarged by H. H. P. Powles, M. I. M. E., A.-M. Inst. C. E. Size, 6 by 3¾ in.; pp. xxxii, 692; figures, 96. Price, $3 (6s.). New York: D. Van Nostrand Company London: Crosby, Lockwood and Son.

Clark's "Manual" has long been one of the standard engineering books of reference, but its size prevents it from being conveniently carried about so as to be always ready for consultation, and, in addition, much of its material is not in a form which is best adapted to the every-day needs of mechanical men. For these and other reasons, the late Mr. Clark prepared a pocket-book, compiled expressly to meet the practical requirements of the mechanical engineer, of which the present is the fifth edition. Mr. Clark's death having occurred a few years ago, this edition has been edited by Mr. H. H. P. Powles, and the opportunity has been taken advantage of to carefully revise and correct the work throughout, without, however, interfering with the original plan of Mr. Clark. The section dealing with electrical engineering has been largely re-written, with additions, so as to adapt it to recent developments. The revised electrical wiring rules issued by the Institution of Electrical Engineers are reproduced in their entirety. In other sections, also, new matter has been added as required, thus bringing the work thoroughly up to date, and maintaining its character as a faithful presentation of modern every-day practice.

Mineral Industry.

The Mineral Industry, Its Statistics, Technology and Trade in the United States and Other Countries to the End of 1902. Vol. XI. Founded by the late Richard P. Rothwell. Edited by Joseph Struthers, Ph. D. Size, 9½ by 7 in.; pp. xxx, 891; illustrations, figures and tables. Price, $5 (£1, 10d.). New York and London: The Engineering and Mining Journal.

Each year the appearance of this work is looked forward to with eagerness by the mining and metallurgical world, and it never fails to meet expectations. To say that the present volume sustains the high reputation of its predecessors is to indicate its great value and interest, which will be even more apparent upon a closer examination. As is well known, this work contains statistics of the production and prices of minerals and metals in all countries, brought up to date and made as

complete as possible. The figures are usually far in advance of government publications, but they are obtained from government records and from other authoritative sources. Besides these statistics, there are reviews of the technical progress made in the metallurgical industries throughout the year, and descriptions of new processes. In general arrangement, the book follows the lines established in its predecessors: The various mineral and metal products are taken up in alphabetical order and discussed from both technical and commercial standpoints, different sections under each general heading being treated by experts in many parts of the world. In addition, there are special chapters on various subjects, each by an authority in his own field. Among such topics in the present volume may be mentioned: Electrochemistry and electrometallurgy; manufacture of mineral wool; rare elements; literature of ore deposits; ore dressing; metallography; alloy steels; pyritic smelting; manufacture and use of titanium and similar alloys; concentration of ores by oil; and sampling and estimation of ore in a mine. There are also statistics of the mining stock exchanges in 1902, a general summary of the import duties of the principal countries of the world, and a comprehensive index. In fact, this work, which has now become practically an annual cyclopedia of the mineral and metal industries of the world, can hardly be dispensed with by any one interested in mining and metallurgy.

Mine Ventilation.

Ventilation in Mines. By Robert Wabner. Translated from the German by Charles Salter. Size, 10 by 6¾ in.; pp. xi, 240; figures, 114; plates, 30. Price, 10s. 6d. ($4.50). London: Scott, Greenwood & Co. New York: D. Van Nostrand Company.

Many years have elapsed since the labors of Guibal for the improvement of mine ventilation, which were so rich in practical results, and in the meantime great progress has been made in improving the air supply of underground workings, and with an increase of knowledge, opinions concerning the dangerous gases occurring in mines have undergone considerable modification. There is, therefore, ample justification for the appearance of a new treatise on mine ventilation, such as the present work, which considers the subject from a modern point of view. This volume covers the ground pretty thoroughly, and besides discussing the theoretical questions involved, it describes and illustrates a great deal of the latest apparatus and many of the recent methods adopted. The description of respiration and rescue apparatus is particularly good. Among the other topics treated may be mentioned: The causes of the contamination of the air of mines; the means of preventing the dangers resulting from this contamination, including the testing of firedamp and firedamp indicators; calculating the volume of ventilating current necessary to free mine air from contamination, with descriptions of pressure gauges and anemometers; determination of the resistance opposed to the passage of air through the mine, with the laws of resistance and formulæ therefor; means for providing a ventilating current; mechanical ventilation; ventilators and fans; the theoretical, initial and true depression of the centrifugal fan; new types of centrifugal fan of small diameter and high working speed; the utilisation of the ventilating current to the utmost advantage and its distribution through the workings; the artificial retardation of the ventilating current; ventilating preliminary workings; blind headings; separate ventilation; and supervision of ventilation. There are many clear illustrations in the text and on plates, and an index completes a very useful and valuable work.

Pattern Making.

The Art of Pattern-Making. A Comprehensive Treatise. Numerous Examples of all Kinds of Pattern Work for Green-Sand, Dry-Sand, and Loam Moulding. Pattern Work for Marine Engines and Screw Propellers. Also, Useful Information and Rules for the Practical Use of Pattern Makers and Others. By I. McKim Chase, M. E. Size, 7½ by 5 in.; pp. vi, 254; figures, 215. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

The literature pertaining to pattern-making is not as extensive as the importance of the subject warrants, and is for the most part scattered through the pages of technical periodicals, so that a systematic treatise, such as the present book, by a man experienced in the art, will prove very acceptable to the whole craft of pattern makers. The subjects chosen for illustration in this work are chiefly those with which the author has had personal experience and were originally written for publication in *Machinery*. He also records the experience of others in pattern-making, examples being selected principally from the correspondence of the *American Machinist*, and embodying whatever in his opinion would be of most interest to the pattern-making fraternity. Providing for the interior of castings, or core-box work, is correctly regarded as the most intricate and important part of pattern-making, and so there are several excellent examples of core-box work described. A great deal of attention is devoted to pattern

work for screw propellers, and different methods of moulding various styles are discussed. Besides giving numerous specific examples of pattern-making, the book contains chapters on subjects of general interest, such as glue and its use, marking, recording and storing patterns, handy tools for pattern makers, shrinkage rules and mensuration, and a great deal of other practical information.

Resistance of Materials.

The Elasticity and Resistance of the Materials of Engineering. By Wm. H. Burr, C. E. Sixth Edition. Size, 9 by 6 in.; pp. xv, 1070; many illustrations and figures. Price, $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Prof. Burr's "Resistance of Materials" has been so long and so favorably known to engineers and students that a new edition of his work is an event in the engineering world. The present edition constitutes almost a new book, one-half or more of the volume being fresh matter, and the general arrangement has also been considerably changed, so as to make it even better adapted than before to serve the double purpose of a work of reference and a text book. As steel has completely displaced wrought iron for structural purposes, this metal as used under all conditions for structures or machines is given extended consideration, including the effects of chemical constitution and shop manipulation. The physical properties of the new steels, such as nickel and manganese steels, are fully given. The same observation applies to aluminum, copper, tin, zinc, and their alloys. There is a remarkably full presentation of all the physical properties, both elastic and ultimate, of the modern Portland-cement mortars and concretes, including beams of those materials. The latest investigations regarding the elastic and ultimate resistances of stone and masonry columns and beams are completely set forth. One of the most important sections of the book is that relating to concrete-steel members. The use of reinforced-concrete is increasing very rapidly, and while there have been various papers and articles dealing with the subject, this is probably the first time in the English language that this class of construction has been systematically and completely treated. A most valuable practical feature is the full set of tables and cuts of rolled shapes taken from the handbook of the Cambria Steel Company. The book is a remarkably complete treatment of all those theoretical and practical questions relating to the great field of application of all classes of engineering materials, in such a way as to be of the most direct value both to the practicing engineer and to the engineering student.

Steel Working.

The American Steel Worker. A Twenty-Five Years' Experience in the Selection, Annealing, Working, Hardening and Tempering of Various Kinds and Grades of Steel. By E. R. Markham. Size, 8 by 6 in.; pp. 343; figures, 160. Price, $2.50. New York: The Derry-Collard Company.

The introduction of the new high-speed steels for cutting tools has aroused fresh interest in the question of the treatment of steel, and has emphasized the importance of the condition of the various tools used in machine-shop work. In order to get satisfactory results from his tools, a mechanic must know something about their nature and a great deal about the proper method of handling them. Such knowledge is given in plain language, with many clear and up-to-date illustrations, in the present book. All the different kinds of work in the treatment and handling of steel which are likely to be encountered by a workman are discussed and described in a very practical manner, which shows the results of long experience. The volume has a complete index, and will be found very useful to all who are concerned with the working of steel.

BOOKS RECEIVED.

Principles of American Forestry. By Samuel B. Green. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Yearbook of the United States Department of Agriculture, 1902. Washington, D. C.

Jahrbuch für das Eisenhüttenwesen. Ergänzung zu *Stahl und Eisen*. By Otto Vogel. Price, 10 marks ($3.35). Düsseldorf: August Bagel.

Proceedings of the Fourth Annual Convention of the American Railway Engineering and Maintenance of Way Association, held at the Auditorium Hotel, Chicago, Illinois, March 17, 18 and 19, 1903. Published under direction of the Committee on Publications. Secretary of the Association: L. C. Fritch, Monadnock Block, Chicago.

New Instruments of Precision from the Ryerson Laboratory. By R. A. Millikan. Price, 25 cents. Chicago. The University of Chicago Press.

Moderne Gesichtspunkte für den Entwurf Elektrischer Maschinen und Apparate. By Dr. F. Niethammer. Price, 8 marks ($2.50.) Munich and Berlin. R. Oldenbourg.

Specifications for Portland and Natural Cements and Portland-Cement Concrete. Price, 10 cents. Published by the American Railway Engineering and Maintenance of Way Association, Monadnock Block, Chicago.

NEWS SUPPLEMENT

The Engineering Magazine—November, 1903

Coming Society Meetings.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Sec.: Prof. L. O. Howard, Cosmos Club, Washington, D. C. Annual meeting, week beginning Dec. 8, at St. Louis.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Annual convention, November, at Chattanooga.

AMERICAN ECONOMIC ASSOCIATION. Sec.: F. A. Fetter, Ithaca, N. Y. Annual meeting, Dec. 29 to Jan. 1, at New Orleans.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, Nov. 20, at Carnegie Hall, 154 W. 57th St.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, 1904, at Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Rgeular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. Sec.: W. M. Mackay, 12 W. 31st St., New York. Annual meeting, Jan. 19 to 21, 1904, at New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 1-4, at New York.

ARCHITECTURAL LEAGUE OF AMERICA. Sec.: J. B. Nettleton. Next meeting, April or May, 1904, at Pittsburg.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meeting, second Thursdays of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday from October to May, inclusive. Electrical Section, Nov. 19. Papers on "Alternating Current Motors for Traction Purposes."

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building, Regular meetings on first Friday of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursdav of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July, and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., 1904, at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Jan. 20, at Milwaukee.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 302 Rialto Building, San Francisco.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS. Sec.: W. L. Capps, 12 W. 31st St., New York. Annual meeting, Nov. 19 and 20, at 12 W. 31st St., New York.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. C. F. Quincy has been elected president of The Railway Appliances Company, in place of Mr. H. K. Gilbert, who has resigned. Mr. Geo. H. Sargent has been elected vice-president, and Mr. Percival Manchester, secretary and treasurer.

—Mr. A. W. Henshaw, formerly of the General Electric Company, Schenectady, N. Y., will henceforth have charge of the Motor Department of the Stanley Electric Mfg. Co., of Pittsfield, Mass.

—Mr. E. W. Roberts, who is well known to the gas-engine trade as a designer and consulting engineer, and as the author of the "Gas-Engine Handbook" and numerous other works on gas engines and automobiles, is fitting up a laboratory at Clyde, Ohio, for the testing of gas and gasoline engines and gasoline automobiles, as well as for calorimetry and analysis of both gas and liquid fuels.

—The members of the Mosely Educational Commission, who arrived in New York early in October, are now actively engaged in investigating all branches of the American educational system, upon which they will report when they return to England.

Industrial Notes.

—The forty-ninth annual report of the Lehigh Valley Railroad Company, for the fiscal year ending June 30, 1903, shows the road to be in a very satisfactory condition. The gross earnings increased 11.43 per cent. over the preceding twelve months and the operating expenses increased 5.56 per cent., while the ratio of expenses to earnings was 71.21 per cent., being a decrease as compared with the last fiscal year of 3.96 per cent.

—The Allis-Chalmers Co., of Chicago, received the contract for the new pump in the Turkey Creek pumping station at Kansas City, Mo. The engine complete has a capacity of 16 million gallons per day, and went into operation in October.

—The National Battery Fan Company, of 14 South Broad St., Philadelphia, has produced a new dry electric battery, which possesses all the good points of the primary battery and at the same time is capable of being recharged like a storage battery, and can be shipped like ordinary merchandise by express or freight to any part of the country. The great advantage of this will be at once apparent, as it permits the furnishing of electric power for fans and other small machines at any point in city or country, thus opening up a field which heretofore could not be reached. The National Battery Fan Co., are desirous of appointing sub-agents throughout the United States, and they will furnish full particulars upon request.

—The Canadian Society of Civil Engineers has lately organized an Electrical Section, the first meeting of which was held on October 15, the special subject for the evening being "The Electrical Equipment of some Canadian Hydro-Electric Plants," introduced in a paper by Mr. R. S. Kelsch, M. Can. Soc. C. E., on "The Reorganization of the Lachine Rapids Hydraulic and Land Company's Power Station," illustrated by lantern projections. There will be other meetings of this section on November 19, January 7, February 11, March 18 and April 17, when papers on various subjects of live interest will be read and discussed.

—Two recent and important contracts by the Union Switch & Signal Company are those for the Interborough Rapid Transit Company (Subway), of New York, and the North Shore Railway of California. The Westinghouse electro-pneumatic system is to be installed on the first named, but a new feature is to be introduced, that of using alternating current. It is obvious that the use of track circuits on third-rail roads, where the rails are used for the return circuit, and at the same time for the signalling circuit, introduces what may be serious complications. In order to avoid these difficulties, the signals will be controlled by alternating current, through relays that are sensitive to alternating current only, and which will not be affected by the direct current used for train service in the subway. On the North Shore Railway, which runs about thirty miles north from Sausalito, California, across the bay from San Francisco, the electric semaphore system of automatic block signals is to be used with a track circuit. This being a high-tension, third-rail electric road, alternating current will be used for the signal system.

—The Pelton Water Wheel Company, of San Francisco, report a splendid business in the manufacture of water wheels. Their plant is working night and day to keep up with the orders. Among the important contracts closed during the past few months for hydro-electric plants, are the following, which aggregate 56,400 horse-power: American River Electric Company, Placerville, Cal., head 575 feet, two double Pelton units, each of 2,500 horse-power capacity. Pike's Peak Hydro-Electric Company, Colorado Springs, Colo., head 2,200 feet, three Pelton wheels, each of 1,500 horse-power capacity. Columbia Improvement Company, Tacoma, Wash., head 850 feet, four Pelton units, each of 7,500 horse-power capacity. Vancouver Power Company, Vancouver, B. C., head 390 feet, three double Pelton units, each of 3,000 horse-power capacity. Northern California Power Company, Anderson, Cal., head 1,150 feet, two double Pelton units, each of 3,000 horse-power capacity. Rock Creek Power and Transmission Company, Baker City, Ore., head 960 feet, two Pelton units, aggregating 1,760 horse-power. Columbus Consolidated Mining Company, one Pelton unit, 494 feet, 660 horse-power capacity. The above is indicative of the

flexibility, both as to head and power, of the Pelton system, as well as of the high regard in which the Pelton wheels are held by engineers.

—James Bonar & Co., Inc., announce to their patrons and the trade that they have been duly incorporated under the laws of the State of Pennsylvania, and have taken over the business heretofore known as James Bonar & Co., of Pittsburg. They will continue to manufacture and handle a full line of first-class steam appliances, adding to the number from time to time as may be necessary to make their line the most complete in this part of the country. They are now erecting a first-class machine shop and brass foundry on their own property at 40th street and A. V. R. R., Pittsburg. This shop is for the purpose of manufacturing their own specialties, and also other machine work. The machinery will be new and of the most modern design, and will be specially adapted to the manufacturing of special work. In addition to this, the shop will be equipped with a modern steam plant, in which is included a special high-pressure boiler for testing purposes, as in the past they have felt the need of such facilities for testing high pressure work. They will therefore be in a position to accept the manufacturing of special work to be used in high pressure, making and testing it complete under actual working conditions before leaving their shops.

—The Canadian Westinghouse Company, Limited, was organized with a capital of $2,500,000 at a meeting held recently at Hamilton, Ontario, and presided over by Mr. George Westinghouse. The new company is a consolidation of all the Westinghouse interests in Canada, which heretofore have been conducted individually. It will take over all the property, patents, and other interests of the succeeded companies, including the sales organization and business of Ahearn & Soper, of Ottawa.

—The Power Specialty Company, among the more important contracts for the installation of their Foster superheaters in electric power stations, report the following work nearing completion: Quincy Station, Old Colony Street Railway Co., Massachusetts Electric Railway; Hartford Electric Light Co., Hartford, Conn.; The Interborough Rapid Transit Co., (New York Underground); Independent Light & Power Co., Quincy, Ill.; The Belt Light & Power Co., Lead, S. D.; Omaha Electric Light & Power Co., Omaha, Neb., and the New York Central Railway Co.

—An immense artificial cascade has been determined upon by the authorities of the Louisiana Purchase Exposition as the center-piece of the semi-circular lay-out of the principal buildings. The cascade itself will be divided into three parts; a large middle cascade with a smaller one at each side, the water flowing directly into the head of the Grand Basin. In all, about 90,000 gallons of water per minute will be supplied at a head of 159 feet, forming the greatest artificial water effect ever attempted. The water will be taken from the Grand Basin itself and will be raised to the top of the cascade by a pumping station located under Festival Hall. The pumping machinery will consist of three 36-inch, single-stage, turbine centrifugal pumps purchased from Henry R. Worthington, of New York City, each driven by a 2,000-horse-power Westinghouse alternating current motor. The total horse-power utilized will thus be 6,000, making this the largest electric pumping station in the world. The pumps and other pieces of machinery for this plant are now being installed at St. Louis.

—The Stanley Electric Mfg. Co., of Pittsfield, Mass., announce the opening of two new sales offices, one at Cincinnati, with headquarters in the Perin Building, in charge of Mr. O. H. P. Fant, and the other in the Century building, St. Louis, Mo., in charge of Mr. F. Johnson.

—Sargent, Conant & Co., Equitable Bldg., Boston, Mass., have recently completed the installation of an electric lighting and power system for the town of Groton, Conn., and will shortly begin work on a similar equipment for the town of Millers Falls, Mass.

—The Reeves Engine Company shipped seventeen engines, aggregating over 3,000 H. P., during the month of September. All but two of these engines are of the Reeves vertical, cross-compound type, and, with the exception of one 400-H. P. and one 30-H. P. machine, they are for direct connection to electric generators, the two mentioned

being designed for power purposes. This is a fine showing considering the fact that the Reeves Engine Co. have been exploiting their product really less than a year.

—A report made by Professor Chamot, on the water furnished to Cornell University by the new filtration plant, shows that the water supply of Cornell is now all that can be desired.

—The Jenney Electric Mfg. Co., of Indianapolis, in order to substantiate their claim that the "Jenney" Linotype Motor is superior in design, efficiency and economical operation, to any on the market, will send their motor to any responsible printing establishment for a thirty-day trial, under a guarantee that it will fully meet the above requirements.

—The Diamond Machine Company, of Providence, R. I., announce that they have purchased the patents, patterns and drawings of the Gorton disk grinders, and will manufacture the full line, twenty-three machines, at their works in Providence, R. I. The shops of the Gorton Machine Co. will probably be employed upon the construction of mining machines embodying important improvements.

—The Carborundum Company is again making enlargements of its plant at Niagara Falls, a fact which is of special interest in illustrating the growth of an entirely new industry. Carborundum was invented in 1891. The first commercial furnace of the company had a capacity of a quarter of a pound a day, and the first sale made was a little lot of twenty carats, sent out on an order from a jewelry house, at a price of 25 cents a carat, equal to $450 a pound. These small furnaces sufficed to supply all demands for the new abrasive for nearly two years, when they were replaced by what seemed at that time to be enormous furnaces, requiring the use of 150 electrical horse power. In 1896 the company built its plant at Niagara Falls, employing furnaces using 1,000 electrical horse-power, with a capacity far in excess of the demands at that time. By 1900 the demand had more than caught up with the production, however, and the capacity was doubled. Last year another 1,000 electrical horse-power was added, but the growth of the business has been so rapid that even with 3,000 electrical horse-power, the company has for months, been unable to fill its orders. A contract has now been made for 2,000 more electrical horse-power, and this will be turned into the works by December of this year, giving the plant a capacity of about ten million pounds of carborundum per annum.

—The Brooklyn Engineers' Club held the first meeting of the season on the evening of October 8th. Besides the usual formal business, a very interesting paper, entitled "A History of Pumps, Ancient and Modern," was read by Mr. John A. Drew, of the Worthington Company. Mr. Drew sketched the development of pumping machines from the early Egyptian "Noria," resembling the familiar well sweep, to the latest triple-expansion, condensing, water-works pumping engines, requiring little more than a pound of coal per horse-power-hour. The paper was illustrated by a large number of lantern slides.

—The Diamond Drill & Machine Co., of Birdsboro, Pa., have opened an office in Pittsburg, in the Farmers' Bank Building, in charge of Mr. G. B. Nutt, the Pittsburg representative of Pilling & Crane, Pilling & Crane being their Pittsburg agents.

—The Nernst Lamp Company, of Pittsburg, has recently established an agency for the sale of Nernst lamps and supplies with The W. G. Nagel Company, Toledo, Ohio; the latter company having, for several years, acted as selling agents for the Westinghouse Electric & Mfg. Co.

—The Brown Corliss Engine Co., of Corliss, Wis., have received an order from the Lorain Steel Co., of Lorain, Ohio, for a 30 and 60 by 60-inch cross-compound Corliss engine.

—President Engler, of the Worcester Polytechnic Institute, while in New York recently had a conference with a number of the leading foundrymen from different parts of the country respecting the building and exhibit which the latter propose to have at the St. Louis Exposition next year. At that time it is proposed to erect and operate a model foundry, fully equipped with all necessary apparatus, and exhibiting in operation all the processes of modern foundry practice. An advisory committee, consisting of many of the prominent foundry experts in the country, has been ap-

pointed to organize the work, and of this committee President Engler is a member. The Worcester Polytechnic Institute has been invited to prepare complete plans for the building, having in mind special reference to ideal conditions as to light, heat, ventilation and sanitation, and to a maximum of economy and efficiency by convenience of arrangement and use of the best modern devices in machinery and methods. Besides furnishing space for all ordinary operations in iron, brass, aluminum, steel and lead, the building is to provide accommodations for a chemical laboratory, an exhibition room, a library and reading room, toilet room and shower baths. This foundry exhibit is designed to be primarily educational in its character, and during the entire time while it is in operation at St. Louis, it will be under the direction and charge of the Worcester Polytechnic Institute. The invitation to design the building comes to the Worcester Polytechnic Institute as a result of the erection, a little over a year ago, of the new foundry building there, which is acknowledged by all to be the best and most complete plant of its kind in the United States.

—The National Motor Boat Exposition will be held February 8th to 20th, 1904, at the new and spacious Herald Square Exhibition Hall, at the junction of Broadway, 34th Street and Sixth Avenue, New York. Dr. Robert Taylor, the director of the Motor Boat Show, has already a list of about thirteen hundred concerns which manufacture motor boats. The distribution of the preliminary prospectus sent out by the management of the Motor Boat Show, brought quick responses expressing the interest of makers of motor boats, motors and auxiliaries, and the prospect is bright, not only for a first show of motor boats, but for its annual repetition.

—Williams Hall, of Lehigh University, South Bethlehem, Pa., which was formally opened in connection with the annual celebration of Founder's Day, on October 8, is situated in the University Park, on the hillside to the rear of the Chemical and the Physical Laboratories, midway between them; its front is in line with the Library. The building is 186 feet long by 70 feet wide; the area of each floor is over 12,000 square feet. The walls are constructed of brick and cement ornamented by carved stone work, and the building is of "Mill" or slow-burning construction. One-half of this building will be devoted to the department of Geology and the other half to the department of Mechanical Engineering. The entire building is thoroughly heated and ventilated by approved modern methods. Williams Hall is named in honor of the principal donor, Prof. E. H. Williams, Jr., of the department of Geology and Mining.

—The *Navy League Journal* for October is an interesting number. It shows as the frontispiece the battleship Illinois, and the portrait of Commodore McDonough is on the cover. Among the notable articles are: 1. "The Splendid Achievements of the American Navy," which recites some of the triumphs of the Navy in the past. 2. "Memorandum of a Naval Staff," by Rear-Admiral H. C. Taylor. 3. "The German Navy League," by Frederick W. Catlin. 4. "Old Ironsides," by Paul Dyer Emmons; with a picture of the Constitution as she appears now in Charlestown navy yard, and a picture of the fight between the Constitution and the Guerriére. 5. "The New Department of Commerce and Labor," with portrait of Hon. George B. Cortelyou, Secretary. 6. "The Naming of our Battleships." 7. "An Object Lesson for Germany." 8. "Rear-Admiral C. W. Rea, Chief Engineer of the Navy;" with portrait. There is a fine picture of the launching of the armored cruiser Pennsylvania and of the gigantic crane, hoisting the turret on the Florida. The Navy League is evidently bound to become a great power in the land, and a list of Sections of the League already established, shows that nearly every large city in the country is interested. The German Navy League has 626,000 members. The British Navy League has nearly half a million and the French Navy League has a large and growing membership and the support of the most distinguished citizens of France. All of these Navy Leagues are exerting a powerful influence in favor of liberal appropriations for new ships. The Navy League of the United States, whose headquarters are at 32 Broadway, New York, should have at least as many members as the foreign organizations.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine When you write.

Automobiles.

The White Bulletin, No. 1, with well illustrated and interesting accounts of the excellent performances of the White steam touring car on track and road, with descriptions of some notable tours made in these steam vehicles. 9¼ by 6¼ in.; pp. 16. White Sewing Machine Co., Cleveland.

Belting.

Pamphlet, with half-tone illustrations and descriptions of high-grade leather belting, belt fastenings, belt dressing, cotton belting, rubber belting, hose, packing, rubber gloves and mittens, and many other kinds of leather and rubber goods. 7½ by 5 in.; pp. 110. J. E. Rhoads & Sons, Philadelphia.

Boring Mills.

Circular, with illustrated description of 8-foot, and other sizes of vertical boring and turning mills, with all the modern improvements, and especially adapted for electric driving. 9 by 6 in.; pp. 4. The J. Morton Poole Co., Wilmington, Del.

Carborundum.

Catalogue No. 4, with handsome illustrations, articles on the manufacture and development of carborundum, a combination of carbon and silicon, accounts of its employment for all kinds of abrasive work and for a variety of other uses, and descriptions of the many forms in which it is manufactured, with telegraph code and general information. 9 by 6½ in.; pp. 88. The Carborundum Co., Niagara Falls, N. Y.

Concrete Mixers.

Catalogue No. 12, with fully illustrated descriptions of the portable gravity concrete mixer, which consists of an inclined steel trough filled with numerous rows of steel pins, staggered to mix thoroughly the sand, cement and broken stone as they pass through, with views of numerous installations of this mixer, and useful information about the various kinds of cement. 4½ by 7½ in.; pp. 64. Contractors Plant Company, Incorporated, Boston.

Conveyors.

Catalogue, with descriptions and half-tone illustrations of shallow-trough belt conveyors, of rubber and cotton, and views of various installations of them; and also, illustrated descriptions of coal and coke crushers. 9 by 6 in.; pp. 27. The Link-Belt Engineering Co., Nicetown, Philadelphia.

Drills.

Catalogue, with illustrations and descriptions of rock and coal drills, both percussion and rotary, operated by steam, compressed air, electricity and hand power, electric mine pumps and hoists, coal-cutting machines, and other mining and conveying machinery. 9 by 6 in.; pp. 40. The Jeffrey Manufacturing Co., Columbus, O.

Dynamos.

Special bulletin, with description and half-tone illustrations of electric generators for railway service and their parts. 10¼ by 7¾ in.; pp. 4. Crocker-Wheeler Company, Ampere, N. J.

Electric Conduits.

Bulletin No. 411, second edition, with illustrations and descriptions of iron-armored insulating conduit for electric conductors, junction boxes, fittings and tools for electric conduit work, together with telegraph code. 9¼ by 7 in.; pp. 48. Sprague Electric Co., 527-531 W. 34th St., New York.

Electric-Motor Starters.

Illustrated circular showing how closely the Ward Leonard electric-motor starting rheostats and switches conform to the United States Navy specifications, and giving a few of the patent claims in this field granted to H. Ward Leonard. 16½ by 9¼ in. Ward Leonard Electric Co., Bronxville, N. Y.

Electric Supplies.

Catalogue, with descriptions and half-tone illustrations of incandescent lamp sockets, both standard and in special finishes, receptacles, rosettes, flush plates, switches, cut-outs, fuses, and many other kinds of electric supplies, together with telegraph code. 3¾ by 6½ in.; pp. 189. The Perkins Electric Switch Mfg. Co., Bridgeport, Conn.

Escalator.

Circular, with illustrations and descriptions of the escalator, or moving staircase, in operation at elevated railway stations and in stores, and which carries a great number of passengers quickly, conveniently and safely. 9 by 7¾ in.; pp. 4. Otis Elevator Company, New York.

Feed-Water Heaters.

Catalogue, with fully illustrated descriptions of the Pittsburgh feed-water heater and purifier, both the open and the closed types, and the Pittsburgh combined feed-water heater and receiver, with all their details; and descriptions and illustrations of the Bonar gauge cock and Bonar oil filters. 9 by 6 in.; pp. 48. James Bonar & Co., Inc., Pittsburg.

Machinery Supplies.

Sheets and circulars, with illustrations, descriptions and prices of portable forges, blacksmiths' blowers, upright post drills, self-opening adjustable dies, die screw plates, and die stocks, reversible ratchet wrenches, Smith adjustable gaskets, and many other kinds of machinery and supplies. Somers, Fitler & Todd Co., Pittsburg.

Machine Tools.

Catalogue and price list No. 2, with illustrated descriptions of improved shaping machines, upright, hand and power drills for a variety of purposes, bolt-cutting and nut-tapping machines, portable forges, tire benders, tire shrinkers, bolt headers, and many other machines and tools, together with lists of all duplicate parts for repairs and complete telegraphic code. 9 by 6 in.; pp. 116. Boynton & Plummer, Worcester, Mass.

Mining Machinery.

Catalogue No. 48, devoted to modern methods of producing coal, with half-tone illustrations and descriptions of all kinds of coal-mining machinery, and useful tables and information. 9 by 6 in.; pp. 154. Also, catalogue No. 49, illustrating and describing diamond drills for the rapid and economical prospecting of mines and mineral and quarry lands. 9 by 6 in.; pp. 152. Sullivan Machinery Company, Chicago.

Nernst Lamp.

Special publication N-7000, containing a well illustrated treatise on the Nernst lamp, which emits a remarkably steady and efficient light on the passage of an electric current through a "glower" composed of oxides of the rare earths, with curves and diagrams showing its operation, and views of places where it is in use. 9 by 6 in.; pp. 24. Nernst Lamp Co., Pittsburg.

Oilers.

Treatise on "How to Oil an Engine," and illustrated catalogue with descriptions of Nugent's patent pendulum crank-pin center oilers, loose pulley oilers, anti-packed telescopic oilers for crank-pins, crosshead pins and eccentrics, oil pumps, oil filters, and other devices for oiling machinery, and also of a reducing motion for steam-engine indicators. 9 by 6 in.; pp. 48. Wm. W. Nugent & Co., Chicago.

Packing.

Booklet devoted to Eagleine special packings, such as ring, pump, square hydraulic, asbestos, ammonia and many other kinds for a great variety of uses. Also booklets devoted, respectively, to Eagleine Hold Fast belt dressing, U. S. Standard boiler compound, and a premium list of useful articles for engineers. Eagle Oil and Supply Co., Boston.

Pneumatic Tools.

Circular No. 42, with illustrations and descriptions of the Chicago plug drill for making holes in quarry and stone work in a rapid and economical manner, the Chicago rock drill, and the Boyer pistol-grip, straight-handle and valveless stone hammers for stone carving, cutting and dressing. 11 by 8½ in.; pp. 4. Chicago Pneumatic Tool Co., Chicago and New York.

Screens.

Catalogue No. 8, with illustrations and description of a flat impact screen for screening and sizing wet or dry ores from 4 to 80 mesh, together with plans for setting one or more of such screens. 9½ by 6½ in.; pp. 16. The Colorado Iron Works Co., Denver.

Steam Power Plants.

Pamphlet, with half-tone illustrations and descriptions of steam power plants which have been installed on the Pacific Coast and the Hawaiian Islands for electric railways, office buildings, university buildings, and many other places, together with high-grade apparatus and machinery for such plants. 8 by 6 in.; pp. 100. Chas. C. Moore & Co., Engineers, San Francisco.

Telpherage.

Circular No. 39, with illustrations and descriptions of the convenient and economical handling, by the electric telpherage system, of miscellaneous freight for railroad and steamship companies at terminal stations, including hoisting, conveying, lowering and tiering. 9 by 6 in.; pp. 12. Also, circular No. 40, showing the application of the telpherage system to storing and handling coal, coke and ashes. 9 by 6 in.; pp. 4. United Telpherage Co., 20-22 Broad St., New York.

Time Recorders.

Illustrated folder, devoted to the Cincinnati time recorder for registering the time of employees. 6 by 3½ in.; pp. 6. Selling Agents, American Watchman's Time Detector Co., Cleveland.

Turbines.

Catalogue of the Trump "model" turbine for low and medium heads and of high grade turbines for heads ranging from 30 to 300 feet, with illustrations of turbines, their parts and their manufacture, plants in various parts of the world where they are installed, descriptive text in English, Italian and Swedish, and useful tables and information. 6 by 9 in.; pp. 80. Trump Manufacturing Co., Springfield, O.

Water-Wheel Governors.

Catalogue devoted to turbine water-wheel governors, with completely illustrated descriptions of different types which are operated by means of oil or water under pressure, switchboard controlling apparatus, methods of connecting governors to water-wheel gates, and principles and general information concerning the speed regulation of water-power plants. 9 by 6 in.; pp. 44. Sturgess Governor Engineering Co., West Troy, N. Y.

Well Machinery.

Circular, form 89, containing sample pages from a larger catalogue, with illustrations, descriptions and prices of jetting well-sinking rigs, elliptical jetting drilling machines, revolving hydraulic well-sinking machines, heavy rotary boring outfits, cable elliptical drilling machines, well auger outfits, pumping engines, well-drilling tools of "adamantine," a new metallic composition, and many other kinds of well-sinking machinery and appliances therefor. 9 by 6 in.; pp. 32. American Well Works, Aurora, Ill.

Wire Rope.

Catalogue and price list E, with illustrations and descriptions of wire rope and cordage of all kinds, sockets, hooks, clips, blocks, sheaves and many other appliances for wire rope transmission installations. 6 by 3¼ in.; pp. 52. Broderick & Bascom Rope Co., St. Louis, Mo.

IMPROVED MACHINERY

New Processes and Appliances

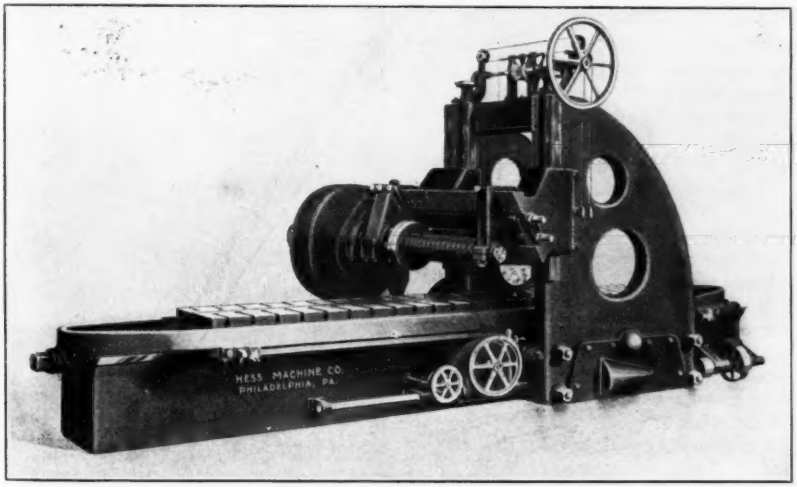
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Fast and Heavy Milling Machines.

THE milling machine has long been considered the standard for the rapid production of light duplicate pieces. In latter years large machines having the general outlines of planers have come to the fore for doing heavy work in direct competition with planing machines. The latest candidate for public favor in this type of machine is the Hess, as here illustrated. This machine in its ability to reduce work rapidly to finished sizes has set up entirely new records. The first machine was built under a stringent contract that guaranteed a cut of 20 inches width, 5/16 inch depth and 4 inches feed per minute in rather tough steel; that meant the removal of 25 cubic inches or 7 pounds of steel per minute, and was more than eight times as much as the best previous practice. The later machines, such as that illustrated, are a considerable improvement on that original machine, so that the makers are prepared to guarantee cuts up to 42 inches wide, taking off ½ inch stock at 10 inches feed per minute in cast iron, corresponding to 210 cubic inches or 54 pounds per minute.

One feature resulting from the extreme rigidity of these machines is their ability to produce truly flat surfaces even though the depth of stock or width of cut on a piece of work vary between wide limits. Heretofore such conditions have always been accompanied by a dropping in of the cutter, producing uneven work. As a direct result of the improved construction of the Hess machine, the usual finishing cut may be dispensed with on a great deal of work.

That the machines are amply powered both as to drive and feed and rigidly built follows from their ability to turn out work at such rates.



HESS MILLING MACHINE.

It is not necessary to enter here into details of construction, as full information will be readily furnished to interested applicants by the makers, The Hess Machine Company, 1202 Pennsylvania Building, Philadelphia, who specially solicit an opportunity to quote the time occupied in finishing work on receipt of sketches or prints.

A World's Record in Coal Hoisting.

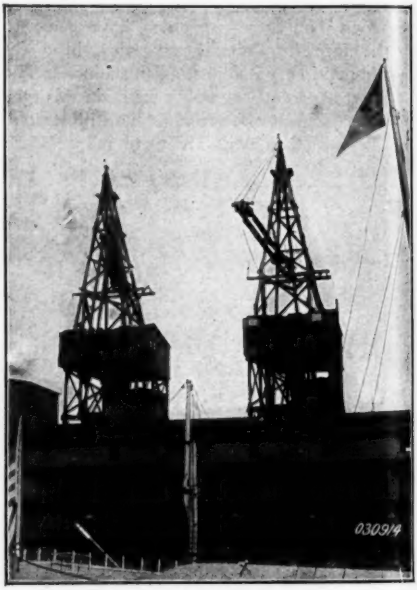
THE steadily increasing bulk in which coal is conveyed by sea and rail and stored for boiler service in high pockets at power stations and plants has led to a demand for increased speed in the necessary hoisting and handling machinery.

Demurrage on steamships and cars is an item to be carefully avoided in economical management, and the large cargoes now shipped to terminals can only be handled with success by specially designed high-speed machinery. The problem is different from, and more difficult than, the familiar one of bulk unloading and storage of coal, ore, or similar materials on the ground level from vessels. The element of height materially affects the machinery design. With a single tower, hoisting to about fifty feet above tide water, forty to sixty tons an hour was, until recently, the common speed, and ninety to one hundred tons was only attained with difficulty in exceptionally favorable circumstances.

The work demanded of coal hoisting towers and their machinery is of the hardest description, both from the unskilled nature of the labor employed, and the shocks to the machinery incidental to this service, and it changes constantly with the nature and size of the coal, which may vary from a soft pea variety contained in open wooden barges, to a hard foreign product in cubes, two feet square, loaded in steel vessels with small hatches.

A world's record for the rapid unloading of coal from freight vessels and barges has been recently established by the C. W. Hunt Company, West New Brighton, N. Y., at the Lincoln Wharf power station of the Boston Elevated Railroad Company. Run-of-mine bituminous coal was raised ninety feet above tide water from one hatch of a vessel and delivered to the storage pockets, cracked to mechanical stoking size, at the rate of three hundred and twenty tons per hour, by one tower. This is an advance of about two hundred per cent. upon the previous best, and marks an important mechanical engineering achievement.

To attain this end, the steam engines of fifty to one hundred combined horse power in common use have been replaced by machinery of three hundred horse power, and the coal-cracking machine attached to the



HUNT COAL-HOISTING PLANT.

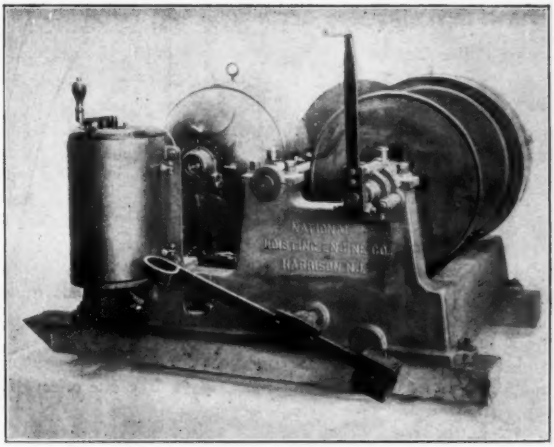
tower cracks to the proper dimensions for automatic stokers, before passing to the pocket the enormous quantity of coal, over five tons per minute, delivered to it from the hoisting machinery. The ordinary small steam shovel has been supplanted by an automatic one of two tons capacity at each lift.

The time occupied in raising two tons of coal from the hold of a vessel to the discharging hopper, nearly two hundred feet above, is only six seconds, while the round trip, involving the operations of lowering and moving the shovel out of the

boom, opening the former, digging up two tons of coal, raising it to the level of the hopper and discharging it therein, is frequently performed in twenty-two seconds.

The installation, shown in the illustration, follows in general design, but in heavier proportion, the standard Hunt steeple tower rig, the moving gear and coal cracker being electrically driven and the hoisting engine direct connected. The towers have to traverse overhead the whole length of the coal storage pocket, and to move thirty feet at a time without changing steam connection. In this way a single tower can operate on each hatch of a vessel in turn or several towers can work simultaneously.

The boom, made to fold up, for the free manipulation of vessels with their rigging, has an overhang of forty feet, and enables the tower to operate on coal steamers of the widest beam and largest dimensions.



CROCKER-WHEELER-NATIONAL ELECTRIC MINE HOIST.

Motor-Driven Mine Hoist.

THE motor-driven friction-drum hoist illustrated herewith has been built to meet the demand for a small, compact, portable, and, as nearly as possible, indestructible machine for use in mines, quarries, on board ships, and for contractors' purposes generally. It is manufactured by the National Hoisting Engine Company, of Harrison, N. J., and is equipped with a Crocker-Wheeler fully-inclosed type series motor which drives the drum through two trains of reducing gears. The portability of the outfit is indicated by the cut, which shows the motor, controller, drum, etc., all supported upon the one cast-iron base. The motor is of the 7½-horse-power size, wound for 220 volts and drawing normally at full load a current of about 30 amperes. The controller, which is of the Cutler-Hammer make, designed for intermittent regulating duty, is of the size to accompany a 7½-horse-power motor and allows twelve speeds in either direction.

At a maximum of speed and power the hoist is capable of lifting 1,500 pounds at the rate of 125 feet per minute with the motor running at 800 revolutions per minute. The position of the operator is at the side of the machine shown in the picture, where, with his left hand on the controller, he can govern the speed of rotation of the drum in either direction, or, with his right hand on the chuck release, may disconnect the drum from the gears and allow it to rotate under the weight of its load while checking the speed by applying the friction band-brake with his foot.

The equipment throughout is admirably adapted to withstand the rough usage and

exposure that it must naturally be expected to receive. The resistance used in connection with the controller is of the Carpenter enclosed form and mounted in a safe position under the base of the frame. The leads between the controller, motor and resistance are run in flexible metallic conduit, and all delicate parts liable to disarrangement are carefully enclosed and protected from dust, moisture and the results of careless handling.

Any further information desired concerning this apparatus, will be gladly furnished by the Crocker-Wheeler Co., of Ampere, N. J.

An Improved Boiler Cleaner.

THE importance of preventing or removing all scale formations from boilers, for reasons of both economy and safety, is so well established, and the difficulty of accomplishing it so well known, that every advancement in this department of engineering is of pecuniary, as well as humane interest, to both the man who pays the coal bills, and the engineer in charge of the power plant.

Innumerable devices and means have been invented to prevent the formation of scale in the boiler, and on the whole the conditions have been slowly improved. Still in the light of our present knowledge, it may well be doubted whether any practical means can be devised that will positively insure the user against the presence of scale in the boilers.

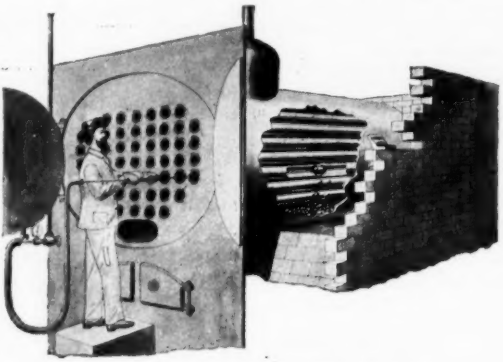
The net result, therefore, is that from time to time the scale that has formed must be removed either by entering the boiler and chipping it off by hand, or by using some mechanical contrivance for doing the same work.

To any one at all familiar with the construction of the boiler of to-day, especially of the return tubular type, where the scale forms on the outside of the tubes, the impossibility of cleaning the tubes of scale by hand is at once apparent, and is the chief reason for the great favor into which mechanical cleaners have sprung with the trade. The inspection of this form of boiler is so difficult that scale is very often present without its being known by the engineer.

The construction of a return tubular boiler is such that all these mechanical cleaners have taken the form of some device or machine which enters the tube, and has a knocker or rapper that may be operated by hand or power, so as to rap or hammer on the inside of the tube sufficiently hard to jar the scale from the outside.

Up to the present time these machines, though simple to handle and effective in operation, have all been designed with but one object in view, namely, to strike a sufficiently hard blow to do effective work. The development of these machines along this line has left them with two most serious defects, one of which is the attendant danger of injuring the tube, and even of puncturing it, while the other lies in the loosening of the tubes in the heads, by the undue heating of the one tube operated, when steam is the motive power.

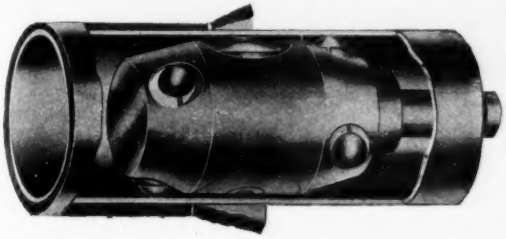
A careful study of the problem at hand has clearly shown that the most effective and least dangerous method of rapping the tube, consists in having the highest possible number of comparatively light raps in a given time, the effect of which will be to set up a more or less local, but very rapid vibration in the walls of the tube, which by reason of the more brittle and non-elastic character of the scale formation, breaks up, loosens and shakes off the latter,



"TORPEDO" BOILER-TUBE CLEANER AT WORK.

without subjecting the tube to any undue strain.

Keeping these points well in mind, the General Specialty Company, of Buffalo, N. Y., has devised a machine in which the motive fluid is applied in the most direct manner, thus insuring the greatest speed of the piston and in which the travel of the double-acting knocker rod, which is firmly secured to the piston, is so limited that though the knocker is capable of exerting a sufficiently hard blow, it could not puncture or injure the tube, because even though the latter were not present to stop the motion of the rod, it would not travel beyond the point where the walls of the tube would be. This construction makes it possible to safely operate the machine at boiler pressure, thus obviating the necessity of using a separate steam gauge or reducing valve to lower the pressure.



"TORPEDO" BOILER-TUBE CLEANER.

For obvious reasons the body of the machine must be made considerably smaller than the inside diameter of the tube, and this, in connection with the rest of the construction, necessitates some means for accurately maintaining the machine in the axis of the tube. This is accomplished by two sets of centering lugs, one ahead and one back of the piston, which are forced out against the inner surface of the tube by steam pressure.

The undue heating of the tube operated on is further avoided by so using the steam that it is expanded to such a point before exhausting into the tube, that its temperature is only a very little above that of the atmosphere.

An actual test of this machine showed a speed of three thousand strokes and upward per minute, according to the pressure used, and the temperature of the tube at the end of thirty minutes was not raised above the point where it could be easily handled without gloves.

The cuts appearing herewith illustrate the cleaner in operation, and further information can be procured from the manufacturers, The General Specialty Co., 514-520 Seneca Bldg., Buffalo.

The Curtis Steam Turbine.

THE most striking feature of steam engineering at the present day is the rapid development of the steam turbine, which is being applied to various uses afloat and ashore, and which is finding one of its largest fields in the driving of electric generators.

In a paper recently read before the New England Cotton Manufacturers' Association by Mr. Austin R. Dodge, are shown the advantages of steam turbines for textile mills, where the electric drive is being largely introduced, and where the steam turbine supplies the most suitable and convenient prime mover.

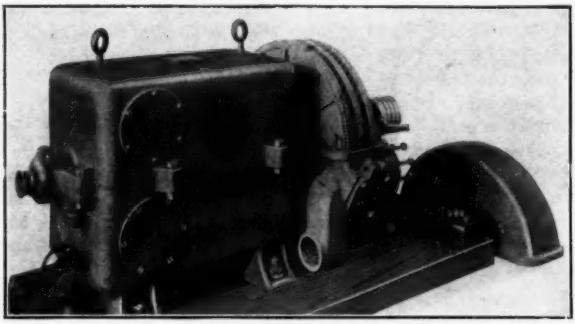
Among the good points of the steam turbine, some of the most apparent are its compactness and simplicity, its small number of moving parts and the little attention it requires.

One of the great advantages of a turbine is due to the entire absence of internal lubrication. Consequently the condensed steam can be returned to the boilers, saving the cost of oil and feed water, often 10 per cent. of the cost of fuel. As no boiler scale is formed while using the same feed water continuously, tube cleaning is unnecessary and the boilers are maintained at the highest efficiency without withdrawal from service.

It is estimated that the saving in attendance charges will average 25 per cent. on the entire station pay roll. A turbine having but one moving part requires no adjustment, unlike a reciprocating engine with a large number of moving parts, which must be carefully inspected at frequent intervals by a skilled engineer. The economy therefore remains constant, which is not true of a reciprocating engine.

One of the principal requirements of tex-

tile mills is uniform speed. A turbine has a large amount of stored energy in its revolving parts and is therefore well adapted for work requiring close regulation.



15-K. W. CURTIS STEAM TURBINE TRAIN LIGHTING SET.

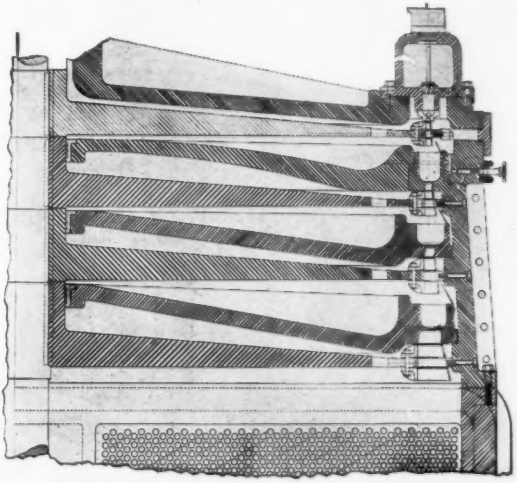
One of the latest types of steam turbines is that brought out in the United States by Mr. Charles G. Curtis, which, in addition to nozzles delivering steam at high velocity to a single wheel, has also stationary vanes which redirect the steam discharged at considerable velocity from the first wheel, due to the relatively low bucket speed, into the second wheel. The velocity of the jet leaving the nozzle is about 2,000 feet per second, while the peripheral speed of the vanes is about 400 feet per second. By this process of fractional abstraction the speed of revolving vanes need not be excessive to secure maximum economy, in other words, to bring the direction of the jet discharged from the last set of vanes parallel to the shaft. With this high steam velocity only a minimum of revolving vanes are necessary, and they rotate in steam which has a lower density, due to the considerable drop in pressure from one stage to the next. There is a large clearance between the outer wall of revolving vanes and the shell, reducing friction due to water of condensation. End thrust is eliminated, as there is abundant

CURTIS STEAM TURBINE IN THE NEWPORT STATION OF THE NEWPORT & FALL RIVER STREET R. R. CO.

opportunity for the pressure to equalize on each side of the revolving discs, and the entrance and discharge angles of the vanes are the same.

In the larger sizes the shaft is vertical and floats on oil under sufficient pressure to balance the weight of the revolving element, which rises a few thousandths of an inch until the clearance is sufficient to permit the discharge of the oil delivered at the centre of the supporting block.

As to first cost of such an installation, a Curtis turbine requires only 7 per cent. of the floor space taken by a horizontal cross-compound engine of the same capacity, and the cost of foundations is in about the same proportion in favor of the turbine. The weight is from 15 per cent. to 25 per cent. that of the reciprocating engine.



ASSEMBLY OF 5000-K. W., FOUR-STAGE CURTIS STEAM TURBINE.

There is no wear, with a moderate amount of superheat, resulting from the action of the steam jet on the vanes, even at a velocity of 2,500 feet per second, as shown by long continued tests.

The variation in speed of the larger units is within two per cent., when the load is varied from no load to full load. Fly-wheels are not required on any type, as the driving force is always transmitted without angular variation, which is a desirable condition when generators are operated in parallel.

Curtis steam turbines have already been installed in several textile mills and in a number of electric central stations, where they have shown up remarkably well and have given great satisfaction.

Further details concerning them and their operation will be gladly given by the General Electric Company, of Schenectady, N. Y.

A Valve-Motion Model.

DO you understand just how the valve moves in the steam chest? Just when it opens the port and admits steam into the cylinder? Just where the piston is at the time and what work it is doing? Just what happens when you hook up the reverse lever and change the valve travel? Then do you know just how a piston valve admits steam and how it differs from a slide valve? How an inside admission valve differs from the outside admission or the slide valve? Why the inside admission requires a direct valve motion? Or how direct and indirect motion differ?

These are but a few of the many things that the D-C valve model makes clear to you. It shows first of all the movement of any valve operated by a link motion; and shows it the full size of a 24-inch stroke engine. Right before you is the valve and its seat as well as the crank, and also the position of the piston in its stroke. You can see at a glance the moment the valve begins to open the port; note the position of the piston and crank and see what the exhaust is doing at this time. In the same way you can follow full port opening and closing, watch the exhaust, and all the time see what happens to the crank and piston. By doing this at different points of cut-off you get a good idea of what goes on inside the cylinder under different conditions of working.

Your observations are not confined to one design of valve or one valve travel, for you can use any kind of valve and change the

eccentric throw in a manner to suit yourself.

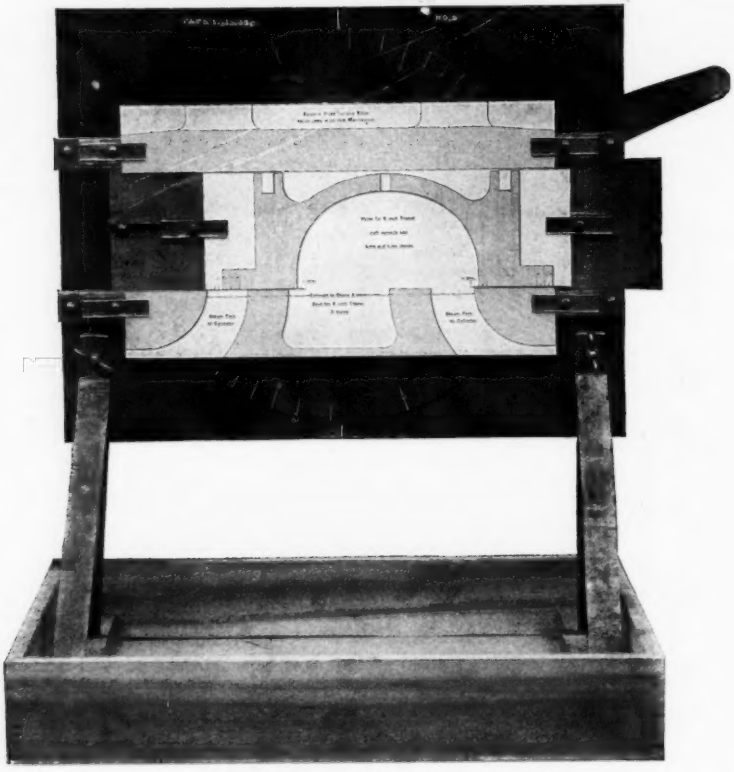
This model shows the action of all the locomotive valves now in use, and is a great help in experimenting with valves of new design.

The action of this mechanism is based on the fact that the motion of a valve driven by the link motion, is the same as that resulting from moving an eccentric across the shaft to obtain different cut-offs. This makes it possible to do away with the eccentric straps and rods.

The valve seats and valve have been practically brought to the center of the axle and the valve, crank and piston positions and movements can be seen at once.

The graduated disk is marked to indicate inches of piston travel and to show where the piston is during the revolution of the crank, which is also visible. The valves and seats are removable and contain directions for use.

The graduations on the motion plate enable one to set for the valve travel desired. If but one travel were used, the plate could be divided into half and quarter stroke, but as it is desired to use different valve travels and watch the effect of each, the graduations given are preferred.



DERRY-COLLARD VALVE-MOTION MODEL.

This valve model is made of steel, and comes in a box which serves as a support on any table or desk. It is 14 by 18 inches, and stands 21 inches high. It shows everything in full size, and explains all kinds of valve motions.

Further particulars will be gladly furnished by the Derry-Collard Co., 256-257 Broadway, New York.